BPCRC Technical Report 2016-01

Polar Weather and Climate Week (June 4-8, 2016)

International Workshop on Coupled Modeling of Polar Environments (June 4-5)

Year of Polar Prediction in the Southern Hemisphere Planning Meeting (June 6)

The 11th Antarctic Meteorological Observation, Modeling & Forecasting Workshop (June 6-8)

International Symposium on Atmospheric Boundary Layers in High Latitudes (June 8)

Byrd Polar and Climate Research Center
The Ohio State University
Columbus, OH 43210, USA

Byrd Polar and Climate Research Center
Polar Meteorology Group
The Ohio State University

THE OHIO STATE UNIVERSITY
BYRD POLAR AND CLIMATE RESEARCH CENTER

Compiled in 2016 by the

Byrd Polar and Climate Research Center

This report may be cited as:

Wille, J. D., S.-H. Wang, and D. H. Bromwich, 2016: Polar Weather and Climate Week, June 4-8, 2016. *BPCRC Technical Report 2016-01*, Byrd Polar and Climate Research Center, The Ohio State University, Columbus, Ohio, USA, 85 pages.

Special thanks to the BPCRC's Lynn Tipton Everett for her assistance in organizing the meetings.

Cover Photo (from United States Antarctic Program Photo Library, http://phtolibrary.usap.gov)
Image Information:
Taken by Peter Rejcek, November 21, 2014
McMurdo Station is located on Ross Island. It is the largest research station in Antarctica and serves as the hub of operations for the U.S. Antarctic Program, which is funded and managed by the National Science Foundation. At right is Observation Hill, which is about 750 feet tall, and at the top is a memorial cross for Robert Falcon Scott and four companions who died in 1912 on the return sledging journey from the South Pole. In the distance is Williams Airfield.

Thanks to our generous sponsors to make these meetings possible:

WMO the Year of Polar Prediction – Southern Hemisphere (YOPP-SH)

The Scientific Committee on Antarctic Research (SCAR)

The International Association on Meteorology and Atmospheric Sciences (IAMAS)

The National Science Foundation (NSF)

The Byrd Polar and Climate Research Center (BPCRC)

The AMOMWF Planning Committee:

Dr. David Bromwich, The Ohio State University (Organizer)

Mr. Scott Carpentier, Australian Bureau of Meteorology

Dr. John Cassano, University of Colorado-Boulder

Mr. Art Cayette, SPAWAR Systems Center

Mr. Steve Colwell, British Antarctic Survey

Dr. Matthew Lazzara, University of Wisconsin and Madison Area Technical College

Dr. Jordan Powers, National Center for Atmospheric Research

Preface

International Workshop on Coupled Modeling of Polar Environments (June 4-5):
The polar version of the (Advanced Research) Weather Research and Forecasting model (Polar WRF) developed and maintained by the Polar Meteorology Group has been used extensively for studies of the weather and climate of both polar regions. Typically, these simulations feature an interactive land surface model (Noah or CLM) but the ocean and sea ice conditions are specified. Looking forward, there is increased interest in using coupled models, not just for global scales, but also for high-resolution regional applications. Consequently, to better capture the fully interactive polar environment, fully coupled atmosphere-ocean–sea ice-wave-land models are increasingly being applied for weather and climate investigations. We invite contributions on the use and development of fully coupled models in high northern and southern latitudes, including those based on the Coupled Ocean-Atmosphere-Wave-Sediment Transport model (COAWST), the Regional Arctic System Model (RASM), and the Model Prediction Across Scales (MPAS). We are hoping to attract broad interdisciplinary modeling participation from atmospheric scientists, physical oceanographers, sea ice specialists, land surface scientists, etc.

Year of Polar Prediction in the Southern Hemisphere (YOPP-SH) Planning Meeting (June 6):
This meeting is sponsored by the WMO Polar Prediction Project and aims to advance the execution of YOPP in the Southern Ocean and Antarctica. The intent is to identify and develop cooperative opportunities that can exist between funded and planned projects in the YOPP time period (mid 2017-mid 2019) which contribute to improved environmental prediction.

The 11th Antarctic Meteorological Observation, Modeling & Forecasting Workshop (June 6-8):
This workshop brings together those with research and operational/logistical interests in Antarctic meteorology and forecasting and related disciplines. As in the past, the annual activities and status of Antarctic observing (especially Automatic Weather Stations) and modeling (especially the Antarctic Mesoscale Prediction System) efforts will be addressed, and feedback and results from their user communities will be solicited. More broadly, this workshop also is a forum for current results and ideas in Antarctic meteorology, numerical weather prediction, and weather forecasting, from contributors around the world. There will be discussions on the relationships among international efforts and Antarctic forecasting, logistical support, and science.

International Symposium on Atmospheric Boundary Layers in High Latitudes (June 8):
This symposium focuses on the atmospheric boundary layer over snow, ice, and water in high latitudes with the scientific focus from small to large scale processes that are responsible or control exchanges through the boundary layer. The symposium is intended to provide an interdisciplinary forum to bring together researchers working in the areas of high-latitude experimental and theoretical studies of the stable and unstable boundary layers over land, ice, water and sea ice, including atmospheric chemistry.

Thank you to those who submitted papers, will make presentations, and who will attend the meetings. We look forward to productive and successful meetings.

On behalf of the Workshop Organizers, the hosts – the Polar Meteorology Group, and Byrd Polar and Climate Research Center – Welcome to Columbus!

4th June, 2016

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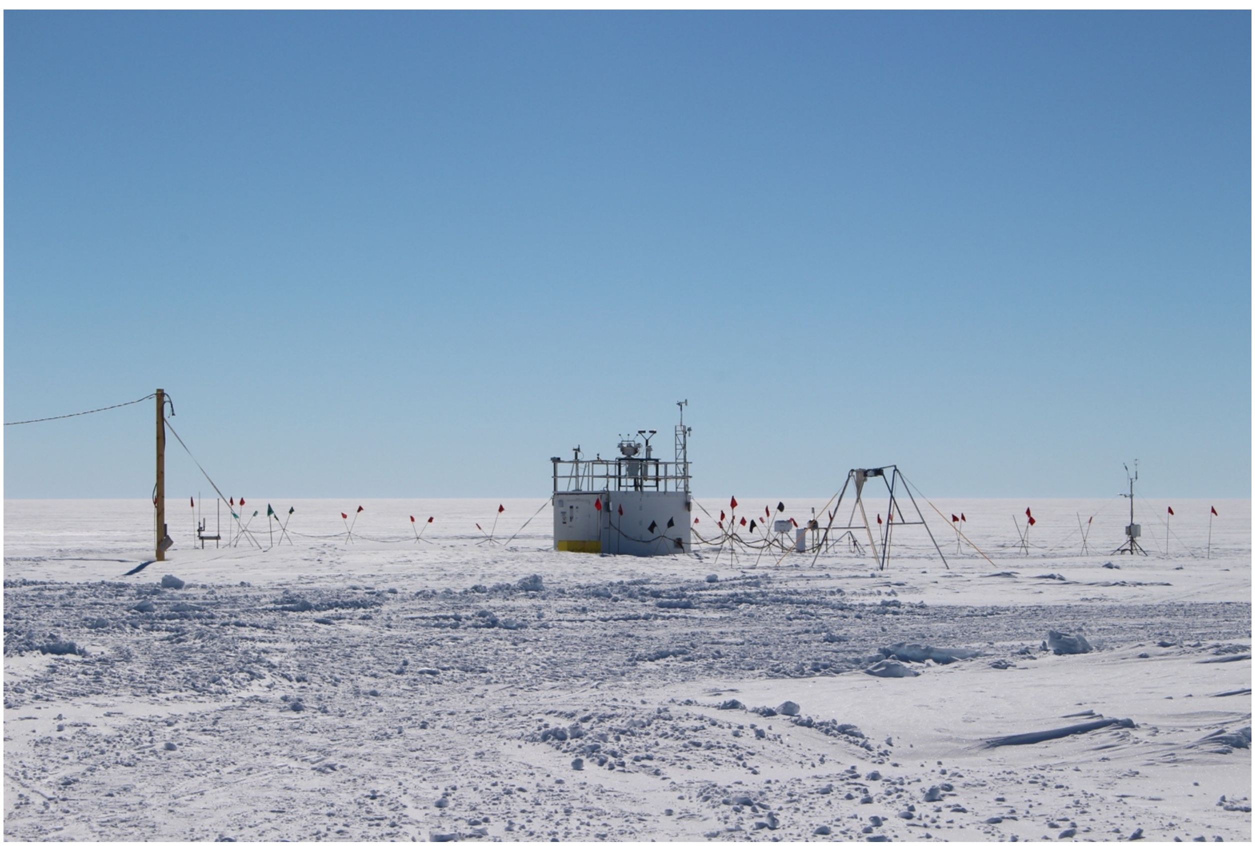

(AWARE site at WAIS Divide, Antarctica. Photo credit Jonathan Wille)

Polar Weather and Climate Week
Hosted by the Polar Meteorology Group
Byrd Polar and Climate Research Center
The Ohio State University
Columbus, Ohio U.S.A.

Saturday, June 4th, 2016 (Room 240, Scott Hall, BPCRC)

International Workshop on Coupled Modeling of Polar Environments (June 4-5, 2016)

0900-0920 Arrival and registration

0920-0930 Opening remarks and introductions
David Bromwich
Byrd Polar and Climate Research Center

Coupled Modeling 0930-1100 (30 minute presentation with 10 minute discussion)
Chairperson: **David Bromwich**

0930-1010
The Regional Arctic System Model (RASM) for Studying High Resolution Climate Changes in the Arctic
Mark Seefeldt, John J. Cassano, Alice K. Duvivier, and Mimi H. Hughes
University of Colorado - Boulder

1010-1050
Modeling Polar Clouds of the ARISE and ASCOS projects
Keith Hines, David Bromwich, and Sheng-Hung Wang
Byrd Polar and Climate Research Center

1050-1110 Break

1110-1150 Coupled Modeling continued

1110-1150
Ice Effect on Wave Propagation in the Marginal Ice Zone
Hayley Shen, Erick Rogers, Jim Thomson, Sukun Cheng, and Xin Zhao
Clarkson University

1150-1320 Lunch

1320-1440 Coupled Modeling continued
Chairperson: **Mark Seefeldt**

1320-1400
Progress towards the development of a coupled ice sheet/ocean/sea ice model
Ben Galton-Fenzi
Antarctic Climate & Ecosystems Cooperative Research Centre

1400-1440
Coastal Antarctic polynyas: A coupled process requiring high model resolution in the ocean and atmosphere
Mike Dinniman and John Klinck
Old Dominion University

1440-1500 Break

1500-1620 Coupled Modeling continued

1500-1540
Developing a coupled atmosphere-ice-ocean modeling system for investigation of Antarctic sea ice and bottom water formation
Jeff Willison
North Carolina State University

1540-1620
Polar COAWST
David H. Bromwich, Lesheng Bai, Michael Dinniman, John Klinck, David Holland, Jeff Willison, and Rouying He
Polar Meteorology Group, Byrd Polar & Climate Research Center, The Ohio State University

1620-1700
Air-sea interactions during an Arctic storm
Zhenxia Long
Fisheries & Oceans, Bedford Institute of Oceanography, Canada

1700 – Adjourn

1830 – Dinner at China Dynasty

Sunday, June 5th, 2016 (Room 240, Scott Hall, BPCRC)

1000-1015 Poster Oral Summaries

1000-1005
Preliminary evaluation of the effective viscoelastic parameters for the Arctic marginal ice zone under various sea states
Sukun Cheng
Clarkson University

1005-1010
A preliminary study to investigate the biogeophysical impact of desertification on climate based on different latitudinal bands
Ye Wang
College of Civil Aviation, Nanjing University of Aeronautics and Astronautics

1010-1015
Developing a coupled atmosphere-ice-ocean modeling system for investigation of Antarctic sea ice and bottom water formation dynamics
Jeff Willison
North Carolina State University

1015–1100 Poster Viewing

1100-1120 Break

1120–1200 Open Discussion of the Feasibility of a Community-Based Polar Coupled Model

1200-1330 Lunch

1330–1500 Open Discussion Continued

1500-1520 Break

1520-1700 Open Discussion Continued

1700 Adjourn

1800-2000 – Icebreaker at Hilton Garden Inn Columbus-University Area

Monday, June 6th, 2016 (Room 240, Scott Hall, BPCRC)

Year of Polar Prediction in the Southern Hemisphere (YOPP-SH) Planning Meeting (June 6th, 2016)

0830-0900 Arrival and registration for AMOMFW and YOPP

0900-0910 Opening remarks and introductions for AMOMFW and YOPP
David Bromwich
Byrd Polar and Climate Research Center

0910–1200 State of the YOPP-SH (12 minute presentation with 3 minute discussion)
Chairperson: **Steve Colwell**

0910-0925
Overview of Ongoing and Planned Coordination Activities for the Year of Polar Prediction - An Update from the ICO
Kirstin Werner, Thomas Jung, Helge Gößling, Stefanie Klebe, and Winfried Hoke
Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research

0925-0940
Planned Observational Campaigns over the Southern Oceans for Determining the Role of Clouds, Aerosols and Radiation in the Climate System: SOCRATES, MARCUS and MICRE
Greg McFarquhar
University of Illinois

0940-0955
Japanese plan for YOPP-SH
Naohiko Hirasawa
National Institute of Polar Research

0955-1010
YOPP-SH Implementation Plan of KOPRI
Sang-Jong Park
Korea Polar Research Institute

1010-1030 Break
Chairperson: **Greg McFarquhar**

1030-1045
BAS contributions to YOPP-SH
Steve Colwell
British Antarctic Survey

1045-1100
USA contributions to YOPP-SH
David Bromwich, L. Bai, A. B. Wilson, S.-H. Wang, and J. P. Nicolas
Byrd Polar and Climate Research Center

1100-1115
German contributions to YOPP-SH
Gert König-Langlo
Alfred Wegener Institute

1115-1130
Australian contributions to YOPP-SH
Scott Carpentier
Bureau of Meteorology – Australia

1130-1145
Potential Italian contributions to YOPP-SH operational period
Vito Vitale
ISAC-CNR

1145-1200
Brazilian contributions to YOPP-SH
Flavio Justino
Byrd Polar and Climate Research Center

1200-1330 Working YOPP-SH Lunch at Byrd

1330-1430 YOPP-SH Open Discussion on Collaborative Activities

1430 – Adjourn YOPP-SH Planning Meeting

1430-1450 Break

Monday, June 6th, 2016 (Room 240, Scott Hall, BPCRC)

The 11th Antarctic Meteorological Observation, Modeling & Forecasting Workshop (June 6-8th, 2016)

1450-1640 – AMPS (15 minute presentation with 5 minute discussion)
Chairperson: **John Cassano**

1450-1510
AMPS Update -- June 2016
Kevin Manning
NCAR

1510-1530
MPAS Testing in AMPS
Jordan Powers
NCAR

1530-1550
Polar WRF
David H. Bromwich, Keith M. Hines, Lesheng Bai, and Sheng-Hung Wang
Byrd Polar and Climate Research Center

1550-1620
AMPS Discussion

1620 – Adjourn

1900 – Dinner at Figlio or Strongwater

Tuesday, June 7th, 2016 (Room 240, Scott Hall, BPCRC)

0900-1020 Automatic weather station networks
Chairperson: **Jordan Powers**

0900-0920
The 2015-2016 UW-Madison Antarctic Automatic Weather Station Program Field Season: Fixing AWS from McMurdo to West Antarctica
David Mikolajczyk, Lee Welhouse, Matthew Lazzara, Carol A. Costanza, Mark Seefeldt, George Weidner, and Linda M. Keller
AMRC, SSEC, UW-Madison

0920-0940
Antarctic Peninsula & Halley region AWS update 2015-16
Rosey Grant, Steve Colwell, John Law, and Mairi Simms
British Antarctic Survey

0940-1000
Antarctic Meteorological Cyberinfrastructure: A Path to Sustainability
Matthew A. Lazzara and Carol A. Costanza
AMRC, SSEC, UW-Madison

1000-1020
Heterogeneous and Homogeneous Observing Networks: The Next Challenge for Antarctica
Matthew Lazzara
AMRC, SSEC, UW-Madison
1020-1040 Break

1040-1200 In-situ observations for model verification
Chairperson: **Matthew Lazzara**

1040-1100
Observations and modeling of planetary boundary layer over marginal ice zone of Amundsen Sea Embayment, West Antarctica during late summer
Pranab Deb
British Antarctic Survey

1100-1120
AMPS and Henry AWS analysis 2009 to 2015
Carol Costanza, Matthew A. Lazzara, and Linda M. Keller
AMRC, SSEC, UW-Madison

1120-1140
A Numerical Simulation of Blizzard caused by Polar Low at King Sejong Station, Antarctica
Hataek Kwon
Korea Polar Research institute

1140-1200
Precipitation Behavior as Measured In-situ by an Acoustic Depth Gauge (ADG) and Simulated by Two Re-Analyses Models at Fleming Glacier, Antarctic Peninsula
Jorge Carrasco
University of Magallanes

1200-1330 Lunch at Byrd with a Tour and Organizing Committee Meeting

1330-1410 In-situ observations for model verification continued

1330-1350
A Self-Organizing Map Based Evaluation of the Antarctic Mesoscale Prediction System Using Observations from a 30-m Instrumented Tower on the Ross Ice Shelf, Antarctica
John Cassano, Melissa A. Nigro, Jonathan Wille, David H. Bromwich, and Matthew A. Lazzara
University of Colorado

1350-1410
NWP performance during the grounding of the RV Aurora Australis, Mawson station, 2016
Scott Carpentier
Bureau of Meteorology – Australia

1410-1510 Antarctic observation studies
Chairperson: **Art Cayette**

1410-1430
Data Stuff
Steve Colwell
British Antarctic Survey

1430-1450
Using the Data Publisher PANGAEA for Meteorological Observations from Antarctica
Gert König-Langlo, Hannes Grobe, Rainer Sieger, and Amelie Driemel
Alfred Wegener Institute

1450-1510
Employing Verification Metrics to Improve Terminal Aerodrome Forecasting in Antarctica
Joseph Snarski
SPAWAR Office of Polar Programs

1510-1520 Break

1520-1553 Oral poster summaries

1520-1523
AMOMFW: The Possibility of a Pronounceable Conference Acronym
Lee Welhouse
AMRC, SSEC, UW-Madison

1523-1526
World Meteorological Organization (WMO) Interests in Antarctica
Steve Colwell
British Antarctic Survey

1526-1529
Spatial and temporal variability of the rainfall distribution over my country in relation to the El-Nino Southern Oscillation (ENSO)
Birhanu Liben
National Meteorological Agency - Ethiopia

1529-1532
ENSO in the Absence of SAM during the Scott South Pole Expedition
Lee Welhouse
AMRC, SSEC, UW-Madison

1532-1535
A Comparison of Automatic Weather Station Measurements at Dome C, Antarctica
Steven Fons
AMRC, SSEC, UW-Madison

1535-1538
A Numerical Simulation Study of Strong Wind Events at Jangbogo Station, Antarctica
Sang-Jong Park
Korea Polar Research Institute

1528-1531
Satellite impact on the analysis of southern hemisphere blocking climatology and variability
Baek-Min Kim
Korea Polar Research Institute

1541-1544
Optimizing an AWS: learning from the practice on field
Lorenzo De Silvestri
ENEA - Territorial and Production Systems Sustainability Department (Italy)

1544-1547
Moisture transport across the Southern Ocean
Maria Tsukernik
Brown University

1547-1550
AMPS Tabular Forecast Verification
Jeffrey Johnson
SPAWAR Office of Polar Programs

1550-1553
The Implications of Climate Change on Antarctic International Relations
Jiyoon Sophia Seol and Matthew Lazzara
AMRC, SSEC, UW-Madison

1553-1740 Poster Viewing

1740 – Adjourn

1900 – Dinner at the Columbus Brewing Company Restaurant

Wednesday, June 8th, 2016 (Room 240, Scott Hall, BPCRC)

International Symposium on Atmospheric Boundary Layers in High Latitudes (June 8th, 2016)

0830-0840 Opening remarks and introductions

0840-0955 Antarctic Boundary Layers (15 minute presentation with 5 minute discussion)
Chairperson: **David Bromwich**

0840-0900
Stable boundary layer regimes at Dome C, Antarctica (Remote Presentation)
Etienne Vignon, Bas J. H. Van de Wiel, Ivo G. S. Van Hooijdonk, Christophe Genthon, Steven J. A. Van der Linden, J. Antoon Van Hooft, Peter Baas, William Maurel, Olivier Traullé and Giampietro Casasanta
Laboratoire de Glaciologie et Géophysique de l'Environnement, Grenoble, France

0900-0920
GABLS4, an intercomparison of models in extremely stable conditions over Antarctica (Remote Presentation)
Fleur Couvreux, E. Bazile, G. Canut, P. LeMoigne, O. Traullé, C. Genthon, W. Maurel, and E. Vignon
CNRM, Météo-France and CNRS, Toulouse, France

0920-0940
The Dry Valley micro-climate as seen by an infrared camera and unmanned aerial meteorological observations
Marwan Katurji, Peyman Zawar-Reza, Tim Appelhans, and Paul Bealing
University of Canterbury

0940-1000
Evaluation of the AMPS Boundary Layer Simulations on the Ross Ice Shelf, Antarctica with Tower and SUMO UAV Observations
Jonathan D. Wille, David H. Bromwich, John Cassano, Melissa A. Nigro, and Matthew A. Lazzara
Byrd Polar and Climate Research Center

1000-1020 Break

1020-1155 Polar Boundary Layers
Chairperson: **Jonathan Wille**

1020-1040
Strong gap flows and SBL structures in northwest Greenland
Guenther Heinemann and Clemens Drüe
Environmental Meteorology, University of Trier, Germany

1040-1100
Use of small unmanned aircraft to study high latitude boundary layers
Gijs de Boer, Dale Lawrence, Scott Palo, Brian Argrow, Jack Elston, Doug Weibel, Ru-Shan Gao, Beat Schmid, Chuck Long, Nathan Curry, Will Finamore, Tevis Nichols, Phillip D'Amore, Gabriel LoDolce, Geoff Bland, Jim Maslanik, and Al Bendure
University of Colorado - Boulder

1100-1120
Atmospheric boundary layer in the Antarctic and Arctic sea ice zone
Alexandra Weiss, John King, Tom Lachlan Cope, and Russ Ladking
British Antarctic Survey

1120-1140
Improving the depiction of topographically-forced winds near Greenland with the Arctic System Reanalysis
Aaron B. Wilson, G. W. Kent Moore, David H. Bromwich, Le-Sheng Bai, Ian Renfrew, Sheng-Hung Wang, Keith M. Hines, Bill Kuo, Zhiquan Liu, Hui-Chuan Lin, and Michael Barlage
Byrd Polar and Climate Research Center

1140-1200
Surface Turbulent Heat Flux in the Arctic System Reanalysis
Flavio Justino, Aaron B. Wilson, David H. Bromwich, Alvaro Avila, Le-Sheng Bai, and Sheng-Hung Wang
Byrd Polar and Climate Research Center

Lunch 1200-1330

1330-1345 Oral Poster Summaries

1330-1335
Atmospheric observations at the Amundsen-Nobile Climate Change Tower in Ny-Ålesund Svalbard
Angelo Viola, Mauro Mazzola, Francesco Tampieri, Christian Lanconelli, and Vito Vitale
ISAC-CNR
&
The vertical structure in the atmospheric boundary layer at Ny-Ålesund
Angelo P. Viola, Francesco Tampieri, Mauro Mazzola, Taejin Choi, and Vito Vitale
KOPRI Korea

1335-1340
Aircraft measurements over Arctic leads
Gert König-Langlo
Alfred Wegener Institute

1340-1345
The impact of atmospheric forcing during active convection in the Labrador Sea
Lena Schulze
Florida State University

1345-1420 Poster Viewing

1420 – Adjourn for International Symposium on Atmospheric Boundary Layers in High Latitudes

1420-1430 Break

Wednesday, June 8th, 2016 (Room 240, Scott Hall, BPCRC)

The 11th Antarctic Meteorological Observation, Modeling & Forecasting Workshop (continued)

1430-1550 Research
Chairperson: **Steve Colwell**

1430-1450
Regional atmospheric circulation and control over near-surface temperature of the Ross Sea coastline of Antarctica
Marwan Katurji, Hanna Meyer, Markus Muller, Pierre Roudier, Peyman Zawar-Reza, Tim Appelhans, and Fraser Morgan
University of Canterbury

1450-1510
Mesocyclone activity over the Southern Ocean from satellite infrared mosaics for winter 2004
Polina Verezemskaya, Tilinina Natalia, Ian Renfrew, and Sergey Gulev
P.P. Shirshov institute of Oceanology, Russian Academy of Sciences, Moscow, Russia

1510-1530
A Case Study of the July 9th, 2015 McMurdo Storm
Billy Tate
SPAWAR Office of Polar Programs

1530-1550
A study of the atmospheric boundary layer in the Weddell Sea using a wind LIDAR
Guenther Heinemann and Rolf Zentek
Environmental Meteorology, University of Trier, Germany

1550-1610 Break

1610-1730 West Antarctica
Chairperson: **Scott Carpentier**

1610-1630
The ARM West Antarctic Radiation Experiment (AWARE)
Dan Lubin, David Bromwich, Andrew Vogelmann, Johannes Verlinde, and Lynn Russell
Scripps Institution of Oceanography

1630-1650
Major melt event in West Antarctica in January 2016. Part 1: Up close and personal
Jonathan Wille, David H. Bromwich, Aaron Wilson, and Julien Nicolas
Byrd Polar and Climate Research Center

1650-1710
Major melt event in West Antarctica in January 2016. Part 2: The big picture
Julien Nicolas, Aaron Wilson, David Bromwich, Jonathan Wille, and Xun Zou
Byrd Polar and Climate Research Center

1710-1730
ENSO response to collapsed WAIS and distinct Astronomical Forcing during the MIS31
Flavio Justino
Byrd Polar and Climate Research Center

1730 – Adjourn for AMOMFW

Columbus, Ohio!

Dining events for the week:
Saturday – China Dynasty. http://www.chinadynasty-cmh.com/

Sunday – Icebreaker at the Hilton Garden Inn Columbus-University Area

Monday – Two options. Figlio Wood Fired Pizza in Grandview Heights
http://www.figliopizza.com/main.html
Strongwater Food and Spirits http://strongwatercolumbus.com/

Tuesday – Columbus Brewing Company Restaurant
http://columbusbrewingco.com/

Fun Facts about Ohio

- Jeni's Splendid Ice Creams has some of the best ice cream in the U.S.A.
- The Cleveland Cavaliers are playing in the NBA Finals this week. Please excuse the local sport's fans if they seem tense.
- The state of Ohio was named after the river 'Ohio'. The Ohio river was named for the Iroquois word, "O-Y-O," meaning "great river.
- Ohio is nicknamed the "Mother of Modern Presidents," as the state was the birthplace of seven American presidents: Ulysses S. Grant, Rutherford B. Hayes, James Garfield, Benjamin Harrison, William McKinley, William H. Taft and Warren G. Harding.
- The first speeding ticket for an automobile driver was given by a policeman in Dayton, Ohio, in 1904, to Harry Myers for going 12 miles per hour on West Third Street
- Ohio native Neil Armstrong was the first man to walk on the moon.
- Cuyahoga River of Ohio was nicknamed "The River That Caught Fire" as the river has caught on fire at least 13 times. The river's pollution and burning covered extensively in the press and the coverage spurred the environmental movement which eventually led to the establishment of Environmental Protection Agency (EPA). Also now the name of a great beer from the Great Lakes Brewing Company.
- There are about 20 different breweries just in the Columbus area.

Abstracts

(WAIS Divide, Antarctica. Photo credit Jonathan D. Wille)

The Regional Arctic System Model (RASM) for Studying High Resolution Climate Changes in the Arctic

Mark Seefeldt, John J. Cassano, Alice K. Duvivier, and Mimi H. Hughes

University of Colorado – Boulder

The Regional Arctic System Model (RASM) is a coupled atmosphere-land-ocean-sea ice model with a focus on climate simulations of the Arctic. The components of RASM include the Weather Research and Forecasting (WRF) model for the atmosphere, the Parallel Ocean Program (POP) for the ocean, the Los Alamos Sea Ice Model (CICE) for sea ice, and the Variable Infiltration Capacity (VIC) land model. The model domain extends from ~45˚N to the North Pole and is configured to run at ~9km resolution for the ice and ocean components and 50km resolution atmosphere and land models. These components are coupled every 20 minutes using CPL7 of CESM. Multi-decadal simulations (1990-2014) show a sensitivity of RASM to a range of selected atmospheric physics processes and parameterizations. There is little to no change in the circulation across the range of simulations. Meanwhile there are significant differences in the surface energy balance and the resultant surface temperature. The changes in surface temperature in the coupled RASM model result in dissimilarities in the corresponding sea ice and SST fields for the coupled RASM climate simulations. A large amount of the differences in the surface temperatures are due to the radiative energy balance, which is impacted by the formation of too much or not enough clouds. Results from additional uncoupled WRF simulations provide greater insight to the identification of preferred physics parameterizations and modifications to the parameterizations to provide the most optimal results for RASM. An example of a science application using RASM will be presented. The deepening of the ocean mixed layer in the Irminger Sea is demonstrated to be the result of strong mesoscale wind events near the southeast Greenland coast.

Modeling Polar Clouds of the ARISE and ASCOS projects

Keith Hines, David Bromwich, and Sheng-Hung Wang

Byrd Polar and Climate Research Center

An overview of the most recent version of Polar WRF, PWRF 3.7.1 is presented. Recently, Polar WRF has been tested in comparison to the August-September 2008 ASCOS and September 2014 ARISE observational studies in the Arctic. Comparisons are made between simulated Arctic low-level clouds and the observations. Adjustments to the cloud condensation nuclei concentration show promise in correcting biases in the simulation of liquid water in Arctic clouds.

Ice Effect on Wave Propagation in the Marginal Ice Zone

Hayley Shen, Erick Rogers, Jim Thomson, Sukun Cheng, and Xin Zhao

Clarkson University

Current polar climate models still miss the ocean wave effect. Waves may break an existing ice cover to enhance lateral melting. Their contribution to increasing upper ocean mixing is also an important factor that may influence the growth/decay of an ice cover. These effects are important in the marginal ice zone. In turn, ice covers can change the speed of wave propagation and attenuate its energy. Wave and ice are thus interacting components in a climate system. This paper will focus on the ice cover effects on wave propagation. In the operational ocean wave model WAVEWATCH III®, several choices are provided to account for ice effects. One of such choice is based on a recent viscoelastic sea ice model. Parameterization and validation of this model are underway. The completed ocean wave model can eventually be integrated into the polar climate models. The viscoelastic sea ice model is being examined using the most recent field data. The wave attenuations are obtained from wave buoy measurements and are fitted by the viscoelastic model using a nonlinear optimization method. We present the preliminary results of this parameterization, and some comparisons between model predictions and field observation.

Coastal Antarctic polynyas: A coupled process requiring high model resolution in the ocean and atmosphere

Mike Dinniman and John Klinck

Old Dominion University

Latent heat polynyas along the Antarctic coast are coupled oceanic/sea-ice/atmospheric phenomena that are crucial to several ocean processes that have global implications including Antarctic Bottom Water formation, transport of heat to melt the base of the floating margins of the Antarctic Ice Sheet, and ocean biological productivity. Examples will be given (from our work and others) showing the importance of high resolution in modeling the atmosphere (especially along the steeply varying coastal terrain) and the ocean (especially over the continental shelf) in order to correctly simulate these ocean processes. However, most of these examples will be from either stand-alone atmosphere or ocean/sea-ice models. As coastal polynyas are inherently a coupled phenomenon, it is crucial that the next step of coupling these models at high resolution be taken in order to accurately simulate, and hope to be able to project, what is happening in both the ocean and the atmosphere.

Developing a coupled atmosphere-ice-ocean modeling system for investigation of Antarctic sea ice and bottom water formation dynamics

Jeff Willison

North Carolina State University

The overarching goal of our research is to understand the significance of the polar ocean in the Antarctic/Prydz Bay region to the global climate system through estimating the formation and export of dense shelf water and illustrating the dynamic processes involved. Specific scientific questions that we seek to address include: (1) What are mechanisms that control circumpolar deep water (CDW) intrusions and its synoptic, seasonal and interannual variations? (2) What are the spatial/temporal variations in distributions of dense shelf water formed in the Prydz Bay shelf region? (3) What are the dynamic processes controlling the export and fate of the dense shelf water?

Coupling between the WRF and Budgell sea-ice models within the COAWST system is developed to provide time and space continuous three-dimensional ocean state estimation. Both in-situ and remote sensing observations and modeling simulation results are used to investigate (i) the local atmosphere-ocean-sea ice interaction and shelf processes that produce dense shelf water and (ii) the dynamic processes that control the shelf water export. Model analyses, in conjunction with observations allow us to systematically examine the synoptic, seasonal and interannual variability of water masses on the shelf, isolate contributions from sea ice formation and CDW intrusion that affect the properties of shelf water, and produce a better assessment of Antarctic bottom water formation. Preliminary results from this modeling effort will be reported in this presentation.

Polar COAWST

David H. Bromwich[1], Lesheng Bai[1], Michael Dinniman[2], John Klinck[2], David Holland[3], Jeff Willison[4], and Rouying He[4]

[1]Polar Meteorology Group, Byrd Polar & Climate Research Center, The Ohio State University
[2]Center for Coastal Physical Oceanography, Old Dominion University
[3]Courant Institute for Mathematical Sciences, New York University
[4]Marine, Earth, and Atmospheric Science, North Carolina State University

An overview will be presented of ongoing efforts to optimize the Coupled Ocean-Atmosphere-Wave-Sediment-Transport modeling system (http://woodshole.er.usgs.gov/operations/modeling/COAWST/) for climate change investigations in the Southern Ocean and Antarctica. Four institutions (see above) are involved. Incorporation of the polar version of the Weather Research and Forecasting (Polar WRF) model and potentially the Los Alamos sea ice model (CICE) will be discussed as will modeling challenges that have been encountered.

Year of Polar Prediction in the Southern Hemisphere (YOPP-SH) Planning Meeting (June 6th, 2016)

Overview of Ongoing and Planned Coordination Activities for the Year of Polar Prediction (YOPP) - An Update from the ICO

Kirstin Werner, Thomas Jung, Helge Gößling, Stefanie Klebe, and Winfried Hoke

Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research

Growing interest in the polar regions in recent years is linked to raising opportunities and risks associated with anthropogenic climate change. Increasing economic, touristic, transportation, and scientific activities in polar regions are leading to more demands for enhanced environmental prediction capabilities to support decision-making. Furthermore, it is increasingly obvious that polar weather and climate have an influence on the lower latitudes. Recognizing this, a number of initiatives are underway which focus on improving polar science and predictions. One particularly important international initiative is the Year of Polar Prediction, or YOPP, which will take place between mid-2017 and mid-2019, centred on the year 2018. YOPP is a major initiative of the World Meteorological Organization's (WMO) World Weather Research Programme (WWRP) and a key component of the Polar Prediction Project (WWRP-PPP). By coordinating an extended period of intensive observing, modelling, prediction, verification, user-engagement and education activities, YOPP will enable a significant improvement in environmental prediction capabilities for the Arctic, the Antarctic, and beyond, on a wide range of time scales from hours to seasons, supporting improved weather and climate services. Prediction of sea ice and other key variables such as visibility, wind, and precipitation will be central to YOPP. Furthermore, the presence of atmospheric linkages between polar and non-polar regions suggests that the benefit of YOPP will extend beyond the polar regions. YOPP will be carried out in three stages – the YOPP Preparation Phase from 2013 to mid-2017, the YOPP Core Phase from mid-2017 to mid-2019, and the YOPP Consolidation Phase from mid-2019 to 2022. An International Coordination Office (ICO) for Polar Prediction was formally established at the Alfred Wegener Institute for Polar and Marine Research (AWI) in September 2013. Activities aimed at YOPP-related outreach beyond the polar prediction science community will be developed ahead of the YOPP Core Phase by the ICO in close collaboration with the communication departments of WMO and AWI.

Planned Observational Campaigns over the Southern Oceans for Determining the Role of Clouds, Aerosols and Radiation in the Climate System: SOCRATES, MARCUS and MICRE

Greg McFarquhar

University of Illinois

The Southern Ocean (SO) region is one of the cloudiest on Earth with clouds largely determine its albedo. Studies shows Earth's climate sensitivity and the Intertropical Convergence Zone location depend upon SO clouds. But, climate models are challenged by uncertainties and biases in the simulation of clouds, aerosols, and air-sea exchanges in this region which trace back to a poor process-level understanding. Due to the SO's remote location, there have been sparse observations of clouds, aerosols, precipitation, and radiation apart from those from satellites.

Therefore, a large international multi-agency effort has been proposed to improve our understanding of the interactions between clouds, aerosols, precipitation, radiation and air-sea exchanges over the SO, including the following: the proposed Southern Ocean Clouds Radiation Transport Aerosol Transport Experimental Study (SOCRATES) where the NSF/NCAR G-V aircraft will make in-situ and remote sensing observations for 1-month between Jan. and March 2018 over a North-South curtain from Tasmania/New Zealand to ~62˚S; the funded Measurements of Aerosols, Radiation and CloUds over the Southern Oceans (MARCUS) experiment where the Atmospheric Radiation Measurement (ARM) Program's Mobile Facility-2 (AMF-2) will make in-situ and remote sensing aerosol, cloud and precipitation measurements on the Australian supply vessel Aurora Australis for 7 months during routine transits between Hobart, Australia and the Australian Antarctic stations Mawson, Davis and Casey, as well as Macquarie Island; and the funded Macquarie Island Cloud Radiation Experiment (MICRE) where ground-instrumentation will be installed on Macquarie Island. The Australian Research Vessel Investigator will also make oceanographic, aerosol and remote sensing observations during the time of SOCRATES.

A comprehensive dataset on the boundary-layer structure and associated vertical distributions of liquid and mixed-phase cloud and aerosol properties across a range of synoptic settings, especially in the cold sector of cyclonic storms, will thus be obtained. This presentation describes how the collected data will be used to address testable hypotheses under the following science themes: synoptically-varying structure of SO boundary layer clouds and aerosols; mechanisms controlling supercooled liquid and mixed-phase clouds and their relationships with cloud condensation nuclei (CCN), ice nucleating particles (INPs), boundary layer dynamics, and overlying free tropospheric aerosols; and sources and sinks of CCN and INPs, including the role of biogenic sources. Parameterization development and testing needs are fully integrated into the experimental design to facilitate systematic confrontation and improvement of leading climate models with data, with an ultimate goal of reducing the bias of SO absorbed shortwave radiation in models. The data will also be used to advance retrievals of clouds, precipitation, and aerosols over the SO.

Japanese plan for YOPP-SH

Naohiko Hirasawa

National Institute of Polar Research

The Japanese plan is now under consideration, including budget acquisition. Our contribution for YOPP-SH will be enhanced radiosonde observation. This presentation will introduce the three parts of the activity with the possibility. The first is enhanced radiosonde observation at Syowa station for 2017-2018 from twice daily at present to four times daily. The second is radiosonde observation on the ice-sheet with daily or twice daily interval. The length of the period will be about a month. The possible place and season will be Dome Fuji station in summer and Mizuho station or Relay point in spring. The third is radiosonde observation from the Japanese icebreaker, Shirase, with daily or twice daily interval in the Indian sector in February to March 2018 and February to March 2019. The above are the maximal activity with the sufficient budget.

Polar WRF

David H. Bromwich, Keith M. Hines, Lesheng Bai, and Sheng-Hung Wang

Polar Meteorology Group, Byrd Polar & Climate Research Center, The Ohio State University

The polar version of the Weather Research and Forecasting model (Polar WRF) has been developed, maintained, and supported by the Polar Meteorology Group for more than 10 years. Since 2009, an updated version has been released annually to the scientific community, currently this is version 3.7.1 that was released in October 2015. A registration system was implemented in 2011 to keep track of usage but the code is freely available to legitimate users. There are over 250 registered users of which 175 are from overseas. The polar physics developments will be summarized. Current applications will be illustrated and future plans outlined.

Observations and modelling of planetary boundary layer over marginal ice zone of Amundsen Sea Embayment, West Antarctica during late summer

Pranab Deb

British Antarctic Survey

Observations from 38 radiosonde launches from 1 February 2014 to 4 March 2014 are used to investigate the vertical profile of planetary boundary layer over the marginal ice zone of Amundsen Sea Embayment, West Antarctica during late austral summer. The radiosonde measurements include temperature, wind speed and direction, relative humidity and pressure. A number of distinct vertical structures are observed, including the frequent occurrence of low-level jets, which are associated with strong temperature inversions.

The observed vertical profiles are compared with output from a recent version of the Polar WRF (Weather Research and Forecasting) model with a spatial resolution of 15 km and 30 vertical levels between the surface and the model top at 50 hPa. The model contains optimized physics and boundary conditions, based on a previous evaluation study. It is shown that the model is able to simulate most of the boundary layer features, including the low-level jets, with reasonable accuracy. Output from the model is subsequently used to increase our understanding of the boundary layer processes and their importance within the marginal ice zone.

Sensitivity to vertical resolution and model top was investigated, demonstrating that increasing the number of vertical levels to 70 improved model error statistics, whereas raising the model to 10 hPa had little effect. In a separate run, the model horizontal resolution was increased to 1.67 km, but no significant improvements were apparent.

AMPS and Henry AWS analysis 2009 to 2015

Carol Costanza, Matthew A. Lazzara, and Linda M. Keller

AMRC, SSEC, UW-Madison

The Antarctic Mesoscale Prediction System (AMPS) is a polar version of the Weather Research and Forecasting (WRF) model, that is used by Antarctic weather forecasters. There have been many different versions of AMPS over the past decade to improve forecasts over Antarctica. The Antarctic Automatic Weather Station (AWS) project maintains sites on the Ross Ice Shelf, West Antarctica, and South Pole, which are often used to verify model output. After visiting Henry AWS, near the South Pole, in January of 2015 there was motivation to get a better understanding of the differences in the measurements between Henry AWS and the AMPS model. Thus a seven-year analysis (2009-2015) was done by matching a time period when Henry AWS data was available during the AMPS WRF era.

A Numerical Simulation of Blizzard caused by Polar Low at King Sejong Station, Antarctica

Hataek Kwon

Korea Polar Research Institute

Polar lows are intense mesoscale cyclones that mainly occur over the sea in polar regions. Owing to their small spatial scale of a diameter less than 1000km, simulating polar lows is a challenging task. At King Sejong station in West Antarctica, polar lows are often observed. Despite the recent significant climatic changes observed over West Antarctica, adequate validation of regional simulations of extreme weather events such as polar lows are rare for this region. To address this gap, simulation results from a recent version of the Polar Weather Research and Forecasting model (Polar WRF) covering Antarctic Peninsula at a high horizontal resolution of 3 km are validated against near-surface meteorological observations. We selected a case of high wind speed event on 7 January 2013 recorded at Automatic Meteorological Observation Station (AMOS) in King Sejong station, Antarctica. It is revealed by in situ observations, numerical weather prediction, and reanalysis fields that the synoptic and mesoscale environment of the strong wind event was due to the passage of a strong mesoscale polar low of center pressure 950hPa. Verifying model results from 3km grid resolution simulation against AMOS observation showed that high skill in simulating wind speed and surface pressure with a bias of -1.1m/s and -1.2hPa, respectively. Our evaluation suggests that the Polar WRF can be used as a useful dynamic downscaling tool for the simulation of Antarctic weather systems and the near-surface meteorological instruments installed in King Sejong station can provide invaluable data for polar low studies over West Antarctica.

Precipitation Behavior as Measured In-situ by an Acoustic Depth Gauge (ADG) and Simulated by Two Re-Analyses Models at Fleming Glacier, Antarctic Peninsula

Jorge Carrasco

University of Magallanes

An analysis of the precipitation behavior in the interior of Fleming Glacier (FG), located at the western side of the Antarctic Peninsula was conducted. For this, data recorded in situ by an Acoustic Depth Gauge (ADG) deployed at about 275 km to the south-southwest of Rothera Station, at an altitude of 1057 masl were used. The ADG continuously operated between December 2007 and October 2008.

The ADG-FG snow accumulation data were compared with simulated precipitation amounts obtained from NCEP/DOE R-2 and Ex-CFSR reanalysis models over the same period. Both simulations show the increasing precipitation accumulation over time, which concurs with the overall observed accumulation behavior. However, either model did not resolve the high variability of accumulation and removal. The atmospheric models only simulate precipitation amounts; therefore, the observed “removal” is not simulated. For this reason, an only accumulation time series was constructed using the ADG-FG data, in order to really compare the observed accumulation with the simulated ones. For this, the removal episodes were removed and then a cumulative sum was performed through a new time series, obtaining an only accumulated snow curve. Comparing this curve with those from the reanalysis, it was found that both NCEP/DOE R-2 and Ex-CFSR curves resemble the overall observed ADG-FG behavior, although the accumulation rate from the NCEP/DOE R-2 simulation decline after mid-May. In fact, the Ex-CFSR performs much better than the NCEP/DOE R-2 model. This is most probably due to the better temporal and spatial resolution of the EX-CFSR model.

A Self-Organizing Map Based Evaluation of the Antarctic Mesoscale Prediction System Using Observations from a 30-m Instrumented Tower on the Ross Ice Shelf, Antarctica

John Cassano, Melissa A. Nigro, Jonathan Wille, David H. Bromwich, and Matthew A. Lazzara

University of Colorado

Accurate representation of the stability of the surface layer in numerical weather prediction models is important since this impacts forecasts of surface energy, moisture, and momentum fluxes. It also impacts boundary layer processes such as the generation of turbulence, the creation of near surface flows, and fog formation. Observations from a 30-m automatic weather station on the Ross Ice Shelf, Antarctica are used to evaluate the near surface layer in the Antarctic Mesoscale Prediction System (AMPS), a numerical weather prediction system used for forecasting in Antarctica. The method of self-organizing maps (SOM) is used to identify characteristic potential temperature anomaly profiles observed at the 30-m tower. The SOM-identified profiles are then used to evaluate the performance of AMPS across patterns with varying degrees of static stability.

The results indicate that AMPS under predicts the frequency of near neutral profiles and instead over predicts the frequency of weakly unstable and weak to moderately stable profiles. AMPS does not forecast the strongly stable patterns observed by Tall Tower. The AMPS forecasts are more statically stable in the median across all wind speeds, indicating a possible mechanical mixing error or a negative radiation bias. The SOM analysis identifies a negative radiation bias under near neutral to weakly stable conditions, causing an over representation of the static stability in AMPS. AMPS has a positive wind speed bias in moderate to strongly stable conditions, which generates too much mechanical mixing and an under representation of the static stability. Model errors increase with increasing atmospheric stability.

Data Stuff

Steve Colwell

British Antarctic Survey

This presentation will look at some of the meteorological data related projects that BAS has been involved with this year, this will include an update on the READER project https://legacy.bas.ac.uk/met/READER/ a demonstration of the new meteorological data interface http://basmet.nerc-bas.ac.uk/sos/ and the data from a project to put weather stations on drifting buoys http://tinyurl.com/j8fqgsd.

Using the Data Publisher PANGAEA for Meteorological Observations from Antarctica

Gert König-Langlo, Hannes Grobe, Rainer Sieger, and Amelie Driemel

Alfred Wegener Institute

Using the Data Publisher PANGAEA for Meteorological Observations from Antarctica Gert König-Langlo, Hannes Grobe, Rainer Sieger, Amelie Driemel. The information system PANGAEA (https://www.pangaea.de/) is operated as an Open Access library aimed at archiving, publishing and distributing georeferenced data from earth system research. The system guarantees long-term availability of its content through a commitment of the operating institutions. Most of the data are freely available. Each dataset can be identified, shared, published and cited by using a Digital Object Identifier (DOI). Data are archived as supplements to publications or as citable data collections. Thus, PANGAEA was chosen as archive for the long term observatory data from the Alfred-Wegener-Institut. Beyond many other institutions the World Radiation Monitoring Center (WRMC) of the Baseline Surface Radiation Network (BSRN) bases.

Employing Verification Metrics to Improve Terminal Aerodrome Forecasting in Antarctica

Joseph Snarski

SPAWAR Office of Polar Programs

Terminal Aerodrome Forecasts (TAFs) are issued in support of air operations for the United States Antarctic Program. Horizontal visibility and cloud ceiling height are two elements in TAFs that are critical for the safe takeoff and landing of fixed wing and rotary wing aircraft. Employing a variety of metrics to analyze the accuracy, bias, and skill in forecasting these elements is a robust method for improvement. Visual Basic for Applications (VBA) coding was used to automate the retrieval and analysis of forecast and observation data. The automation allowed for four new metrics to be calculated. The Snarski Bias Score expresses optimistic and pessimistic biases in TAFs as the average categorical difference between the forecasted element and the observed element. Mean absolute error describes the magnitude of forecast errors. Heidke Skill Score and the Hanssen-Kuiper Discriminant are two measures for determining skill in multi-category forecasts. Tracking these metrics allows for short-term alterations to forecasting technique to improve accuracy. Future directions might include an expansion with more metrics and the verification of field camp TAFs.

Stable boundary layer regimes at Dome C, Antarctica

Etienne Vignon, Bas J. H. Van de Wiel, Ivo G. S. Van Hooijdonk, Christophe Genthon, Steven J. A. Van der Linden, J. Antoon Van Hooft, Peter Baas, William Maurel, Olivier Traullé, and Giampietro Casasanta

Laboratoire de Glaciologie et Géophysique de l'Environnement, Grenoble, France

Multi-year continuous observations along a 45m tower at Dome C on the high Antarctic Plateau demonstrate the existence of two physical regimes in the stable boundary layer. The first regime is characterized by strong winds, a moderate temperature inversion and strong and continuous turbulence responsible for a net temperature and coupling between the surface and each measurement levels in the boundary layer. The second regime takes place in low wind conditions and is associated to a very weak turbulence activity, occurrences of top-down turbulence and very large temperature inversions, occasionally reaching 30 K between 10m and the ground. An analysis of the curvature of the vertical temperature profile in each regime is then performed revealing two types of profile shape: the ' S ' shape and the ' exponential ' shape.

GABLS4, an intercomparison of models in extremely stable conditions over Antarctica

Fleur Couvreux[1], E. Bazile[1], G. Canut[1], P. LeMoigne[1], O. Traullé[1], C. Genthon, W. Maurel[1], and E. Vignon[2]

[1] CNRM, Météo-France and CNRS, Toulouse, France
[2] LGGE, Grenoble, France

The intercomparison uses observations collected at the Dome-Concordia (Dome-C) Research Station in Antarctica during the summer, and in particular the observations acquired on the 45-m tower. This site was chosen for its homogeneous surface with a low conductivity as snow and on a flat topography. Three types of numerical simulations were intercompared: 30 hours runs of single column model (SCM, 11 different models), 24 hours of large eddy simulations (LES, 7 different models) and 15-day offline land-snow model (LSM, 10 different models) runs. A large variability in surface fluxes was highlighted in all the types of simulations with variations around 30 W/m² during daytime and nighttime which is about 100 % of the ensemble mean value. Sensitivity to the albedo, roughness length and emissivity as well as sensitivity to the horizontal and vertical resolution were carried on to analyze further the causes of this variability. Eventually, LES ensembles are analyzed to determine the main mechanisms involved in the mixing occurring through the entire day.

The Dry Valley micro-climate as seen by an infrared camera and unmanned aerial meteorological observations

Marwan Katurji, Peyman Zawar-Reza, Tim Appelhans, and Paul Bealing

University of Canterbury

It is possible to study the effects of turbulence on boundary-layer climates in a novel way by recording rapid fluctuations of surface temperature by ground-based fast remote sensing of infrared radiation (IR) emitted by terrestrial objects (time sequential thermography). We will demonstrate the potential of using research grade IR-cameras to study microclimates of the Dry Valley environment. This research will lead to the expansion of the use of cooled and uncooled infrared cameras beyond the usual thermal detection imaging and towards expanding our knowledge of surface-atmospheric interaction processes.

Evaluation of the AMPS Boundary Layer Simulations on the Ross Ice Shelf, Antarctica with Tower and SUMO UAV Observations

Jonathan D. Wille, David H. Bromwich, John Cassano, Melissa A. Nigro, and Matthew A. Lazzara

Byrd Polar and Climate Research Center

The Alexander Tall Tower! (ATT) automated weather station on the western Ross Ice Shelf provides a temporally rich dataset that displays the dynamics of the lower Antarctic boundary layer. Maintained by a joint team at the Space Science and Engineering Center (SSEC) and the Cooperative Institute for Research in Environmental Sciences (CIRES), the ATT provides temperature, moisture, wind speed, wind direction, pressure, longwave radiation, and shortwave radiation measurements at 10-minute intervals to a height of 30m. In January 2014, the same researchers from CIRES conducted a field campaign using aerial Small Unmanned Meteorological Observer (SUMO) vehicles to measure planetary boundary layer (PBL) conditions near the (ATT) site. Both datasets are compared against the AMPS-Polar WRF to independently examine the performance of the model PBL stability.

For the analysis of the 2011-2012 Alexander Tall Tower! data, the 5-km AMPS Polar WRF data is run daily at 00z and 12z and each model run is given a 12-hour spin up and the subsequent 12-23 forecast hours are concatenated to create a continuous hourly forecast record. The SUMO flight data contains observed temperature and relative humidity, and calculated wind speed and wind direction. The SUMO flight data and ATT data are compared against vertically and horizontally interpolated 3-km AMPS Polar WRF data up to 800m above the surface. On a synoptic scale, European Centre for Medium-Range Forecasting Era-Interim and Polar WRF are utilized to identify possible sources of error in the AMPS-Polar WRF PBL.

From the combined analysis from the ATT – AMPS climatology and the SUMO case study, the most common errors are: an annual dry bias in AMPS Polar WRF, a weakness in atmospheric stability with underestimated inversion strengths, overestimated thicknesses when the PBL is stratifying, and a persistent overestimation of wind speeds. During the SUMO case study, when PBL inversions are present AMPS Polar WRF overestimates the PBL thickness by 100m. The ATT climatology shows a 10% dry bias year round while significantly underestimating the SUMO observed relative humidity on four of the six case study days, with the synoptic charts indicating the errors are systematic regardless of synoptic conditions. A high wind speed bias also appears four of the six days during the case study and during winter 2011 from the ATT observations. The synoptic charts during the case study suggest the wind speed errors are likely related to katabatic flow placement errors, overestimating the strength of cyclones over the Ross Sea, and overestimating barrier wind jet strengths. The current goal is to modify inadequate model physics to improve the accuracy of the PBL.

Strong gap flows and SBL structures in northwest Greenland

Guenther Heinemann and Clemens Drüe

Environmental Meteorology, University of Trier, Germany

Gap flows and the stable boundary layer (SBL) were studied in northwest Greenland during the aircraft-based experiment IKAPOS (Investigation of Katabatic winds and Polynyas during Summer) in June 2010. The measurements were performed using the research aircraft POLAR 5 of Alfred Wegener Institute (AWI, Bremerhaven). Besides navigational and basic meteorological instrumentation, the aircraft was equipped with radiation and surface temperature sensors, two laser altimeters, and video and digital cameras. In order to determine turbulent heat and momentum fluxes, POLAR 5 was instrumented with a turbulence measurement system collecting data on a nose boom with a sampling rate of 100 Hz.

Use of small unmanned aircraft to study high latitude boundary layers

Gijs de Boer, Dale Lawrence, Scott Palo, Brian Argrow, Jack Elston, Doug Weibel, Ru-Shan Gao, Beat Schmid, Chuck Long, Nathan Curry, Will Finamore, Tevis Nichols, Phillip D'Amore, Gabriel LoDolce, Geoff Bland, Jim Maslanik, and Al Bendure

University of Colorado - Boulder

In this presentation, I will give an overview of recent field campaigns that use small unmanned aircraft to obtain measurements of the boundary layer in high latitude environments. This includes measurements of thermodynamic quantities, as well as winds, radiation and aerosol properties. The measurements to be presented were obtained over a variety of seasons at Oliktok Point, Alaska. These systems provide a unique new perspective, allowing scientists to get information on spatial variability (both horizontal and vertical) of atmospheric structure and turbulence, evaluate turbulent fluxes over a variety of surface types, and learn about the vertical distribution of aerosol particles and its impact on radiation in the lower atmosphere.

Atmospheric boundary layer in the Antarctic sea ice zone

Alexandra Weiss, John King, Tom Lachlan Cope, and Russ Ladking

British Antarctic Survey

Airborne observations of the atmospheric boundary layer in the Antarctic sea ice zone were conducted to investigate the parameterization of energy budget parameters in the atmospheric boundary layer, such as the turbulent and radiative fluxes. For the testing and validation of model parameterizations of air-sea fluxes, we determined the effective temperature zT_eff and aerodynamic roughness lengths zo_eff of the ice-covered sea. The effective roughness lengths are needed as input parameter for the bulk parameterization of turbulent fluxes in numerical weather and climate models. zT_eff and zo_eff are highly variable in the Antarctic Weddell and Bellingshausen Sea ice areas. The roughness lengths depend strongly on the sea ice conditions. Current parameterization schemes used in the weather and climate models are compared with our observations and the majority are found to be unrepresentative. For example, our observations show that the parameterization assumption, that the temperature and aerodynamic roughness lengths have the same value, can cause large errors in model output of turbulent fluxes. Moreover, we determined the effective radiative fluxes over various sea ice conditions and investigate the parameterization of sea surface albedo with surface temperature data. In general, the sea surface albedo was inverse related to the sea surface temperature. Quality assessments of commonly used temperature-albedo parameterization schemes showed that different functions are appropriate for certain sea ice conditions.

Improving the depiction of topographically-forced winds near Greenland with the Arctic System Reanalysis

Aaron B. Wilson[1*], G. W. Kent Moore[2], David H. Bromwich[1,3], Le-Sheng Bai[1], Ian Renfrew[4], Sheng-Hung Wang[1], Keith M. Hines[1], Bill Kuo[5], Zhiquan Liu[6], Hui-Chuan Lin[6], and Michael Barlage[7]

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Southern Greenland experiences a number of high speed low-level wind events that result from topographic flow distortion including tip jets, barrier winds, and katabatic flows. Even though the use of global atmospheric reanalyses has advanced our understanding of these phenomena, the mesoscale nature of these events mean that their structures are poorly resolved with global products. The Arctic System Reanalysis (ASR), a high-resolution regional assimilation of model output, observations, and satellite data across the mid- and high latitudes of the Northern Hemisphere has been performed at 30 km (ASRv1) and 15 km (ASRv2) horizontal resolution for the period 2000 – 2012 using the polar version of the Weather Research and Forecasting (WRF) model and the WRF Data Assimilation (WRFDA) System. ASR's high-resolution land surface description leads to more accurate representation of terrain with improved mesoscale structure of topographically-forced wind events as well as atmospheric circulation throughout the Arctic. Comparisons with surface and upper-air observations, as well as research aircraft flights during the Greenland Flow Distortion Experiment (GFDex), show ASRv2 more accurately captures wind speeds that are underestimated (overestimated) by ERA-Interim during high (low) wind events. These results confirm that utilizing a fine-horizontal grid size, such as the one implemented in ASRv2, is key to characterizing the impact of Greenland's topography on the regional wind field and climate. However, some features of the wind field remain under-resolved.

Surface Turbulent Heat Fluxes in the Arctic System Reanalysis

Flavio Justino[1*], Aaron B. Wilson[2], David H. Bromwich[2,3],
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This study compares sensible (H) and latent (LE) heat fluxes over the Northern Hemisphere derived from the Arctic System Reanalysis (ASR) and a selection of current-generation global reanalyses to large-scale objectively-analysed gridded products and satellite estimates. Differences in H and LE among the reanalyses are strongly linked to the wind speed magnitudes and vegetation cover. ASR's wind speeds match closely with observations over the northern oceans, leading to an improved representation of H compared to the global reanalyses. Comparison of evaporative fraction shows that the global reanalyses are characterized by a similar H and LE partitioning from April through September resulting in weak intra-seasonal variability. However, the higher horizontal resolution and weekly modification of the vegetation cover based on satellite data in ASR provides an improved snow-albedo feedback related to changes in the leaf area index. Hence, ASR better captures the small scale-processes associated with day-to-day vegetation feedbacks with particular improvements to the H over land. All of the reanalyses provide realistic dominant hemispheric patterns of H and LE and the locations of maximum and minimum fluxes, but they differ greatly with respect to magnitude, especially with respect to LE over oceanic regions.

Regional atmospheric circulation and control over near-surface temperature of the Ross Sea coastline of Antarctica

Marwan Katurji, Hanna Meyer, Markus Muller, Pierre Roudier, Peyman Zawar-Reza, Tim Appelhans, and Fraser Morgan

University of Canterbury

This research will investigate the spatiotemporal variability of near-surface air temperature across the entire Ross Sea Region (RSR) for the year 2013. Near-surface air and land surface temperature is the main driver behind Antarctica's terrestrial biodiversity and understanding how topography and atmospheric circulation patterns control its regionalization is important. We hypothesize that the regional variability of coastline warming is a result of the interaction of wind flow with the complex topography of the RSR, and by linking and identifying these processes at the relevant spatial resolution we will gain a better understanding of how climate change could manifest itself at the regional scale. LST time-evolving patterns and the derived air temperature product, in both space and time, from the MODIS sensors on board Aqua and Terra satellites will be linked to atmospheric circulation processes and classifications within the RSR via a regional climate model.

Mesocyclone activity over the Southern Ocean from satellite infrared mosaics for winter 2004

Polina Verezemskaya[1,2], Tilinina Natalia[1], Ian Renfrew[3], and Sergey Gulev[1,4]

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[4]Natural Risks Assessment Laboratory, Moscow State University, Russia

Satellite based estimations of cloud shapes and mesocyclones produce realistic picture of mesocyclone activity however they suffer from time-consumption that characterize manual tracking of mesocyclones from satellite images. To fill the gap in realistic picture of mesocyclone activity in Southern Hemisphere we present the new unique database of mesoscale vortexes (<1000 km in diameter) activity for one winter 2004 over the Southern Ocean.

A Case Study of the July 9th, 2015 McMurdo Storm

Billy Tate

SPAWAR Office of Polar Programs

On 9 July 2015 an Extreme Wind Event (EWE) struck McMurdo Station, Antarctica. Observations from the McMurdo Weather Office recorded a peak wind of 43.7 m s-1, with sustained winds reaching 32.9 m s-1. Observations from nearby Pegasus Field recorded a peak wind of 56.6 m s-1, with higher gusts; the observed winds at Pegasus Field were substantially higher than those recorded by nearby automatic weather stations. The 9 July 2015 storm was also significant in that it produced an estimated 52 inches of snowfall at McMurdo Station from 1.04 inches of liquid water equivalent (LWE), shattering the previous July daily snowfall record of 7 inches. This case study will: examine the synoptic and mesoscale situations that led to the EWE, explore the potential impact of the mountain wave system from upstream orography, and reanalyze the snowfall estimate based on snow density and snow/water ratios.

A study of the atmospheric boundary layer in the Weddell Sea using a wind LIDAR

Guenther Heinemann and Rolf Zentek

Environmental Meteorology, University of Trier, Germany

The LIDAR was operated continuously between 23 December 2015 and 30 January 2016. Vertical profiles from VAD scans every 10min were the routine mode. The maximum range of the LIDAR is 10km, but it was used only for a range up to 3600 m due to the low aerosol concentration in the Antarctic. The comparison with radiosondes launched from the research vessel showed overall good results, but also the limitations of the wind profiles of the radiosonde in the shallow boundary layer. During a special observation period in the polynya in the lee of iceberg A23A two low-level jets could be measured in detail. An exceptional convergence line could be measured close to the ice shelf near Halley Station.

The ARM West Antarctic Radiation Experiment (AWARE)

Dan Lubin, David Bromwich, Andrew Vogelmann, Johannes Verlinde, Lynn Russell

Scripps Institution of Oceanography

West Antarctica is one of the most rapidly warming regions on Earth, and its changing climate in both atmosphere and ocean is linked to loss of Antarctic ice mass and global sea level rise. The specific mechanisms for West Antarctic Ice Sheet (WAIS) warming are not fully understood, but are hypothesized to involve linkage between moisture from Southern Ocean storm tracks and the surface energy balance over the WAIS, and related teleconnections with subtropical and tropical meteorology. This present lack of understanding has motivated a climate science and cloud physics campaign jointly supported by the US National Science Foundation (NSF) and Department of Energy (DOE), called the Atmospheric Radiation Measurement Program (ARM) West Antarctic Radiation Experiment (AWARE). The DOE's second ARM Mobile Facility (AMF2) was deployed to McMurdo Station on Ross Island in November 2015 and will operate through December 2016. The AMF2 includes (1) cloud research radars, both scanning and zenith, operating in the Ka- and X-bands, (2) high spectral resolution and polarized micropulse LIDARs, and (3) a suite of shortwave and longwave broadband and spectral radiometers. A second suite of instruments is deployed at the WAIS Divide Ice Camp on the West Antarctic plateau during December 2015 and January 2016. The WAIS instrument suite provides (1) measurement of all surface energy balance components, (2) a polarized micropulse LIDAR and shortwave spectroradiometer, (3) microwave total water column measurement, and (4) four times daily radiosonde launches which are the first from West Antarctica since 1967. There is a direct linkage between the WAIS instrument suite and the AMF2 at McMurdo, in that air masses originating in Southern Ocean storm tracks that are driven up over the WAIS often subsequently descend over the Ross Ice Shelf and arrive at Ross Island. Preliminary data are already illustrating (1) the prevalence of mixed-phase clouds and their role in the surface energy balance, the impact of warm and moist air advection from Southern Ocean storm tracks onto the WAIS, and (3) large vertical velocities in Ross Island stratiform clouds that are a distinct contrast from the Arctic. A critical aspect of AWARE is that data from this campaign become publicly available in the DOE ARM archive, with no restrictions or proprietary periods, as soon as the quality control is complete. We therefore encourage maximum use of AWARE data for polar atmospheric process understanding and to help motivate new Antarctic field campaigns.

Major melt event in West Antarctica in January 2016. Part 1: Up close and personal

Jonathan Wille, Aaron Wilson, Julien Nicolas, and David H. Bromwich

Byrd Polar and Climate Research Center

Between January 10^{th}-14^{th}, 2016, temperatures at WAIS (West Antarctic Ice Sheet) Divide approached the melting point and lead to wet snow conditions hampering camp operations. Across Marie Byrd Land and the Western Ross Ice Shelf, melting conditions were recorded by various AWS stations and field reports. Unofficially, rain was reported by the Spot 1 Traverse as they approached the Leverett Glacier. A highly amplified ridge was responsible for advecting warm, marine air deep into the continent. Part 1 will focus on the surface and synoptic components of the major melt event in West Antarctica by using AWS data, METARs, and ERA-Interim reanalysis data. I will provide a personal account of how this melt event affected aircraft and camp operations from my perspective as a Weather Observer at WAIS Divide. Julien Nicolas will discuss in Part 2 the SAM and ENSO teleconnections that truly made this melt event so unusual and provide a more climatological context for melt events in West Antarctica.

The January 2016 melt event in West Antarctica: A climate perspective

Julien Nicolas, Aaron Wilson, David Bromwich, Jonathan Wille, and Xun Zou

Byrd Polar and Climate Research Center

In December 2015, two important ingredients seemed to be present to generate above-average surface melt in West Antarctica. First, one of the strongest El Niño events on record was reaching its peak intensity in the Tropical Pacific, and its typical teleconnection pattern (high pressure anomalies) was forming in the South Pacific. If this pattern were to move far enough south, it could steer warm air toward the Ross Sea sector of West Antarctica and potentially cause widespread surface melting. The second ingredient was at higher latitudes: the Southern Annular Mode was oscillating between a weak and neutral state. In other words, the El Niño Southern Oscillation (ENSO) and the SAM were close to being in phase (i.e., El Niño with weak SAM). It is generally under these conditions that the El Niño teleconnection has the greatest impact on the climate of West Antarctica, and that surface melt is more likely to occur. Yet nothing happened in December: satellite imagery revealed no unusual surface melt in the area. As 2015 was coming to an end, the SAM had switched to a very strong state, unfavorable to melting conditions. In short, the melting season seemed to have ended before it had even begun.

Things abruptly changed on January 10, 2016. This day marked the beginning of a major surface melt event in the Ross Sea sector. Melting conditions persisted for up to 15 days in some places according to satellite observations. Over the course of the following two weeks, virtually all areas of the Ross Sea sector below 1000 m experienced surface melting. In his presentation, Jonathan Wille will describe the synoptic circumstances that led to this event, namely the presence of a strong pressure ridge that caused strong advection of warm marine air toward the Ross Sea sector. In this presentation, I will use the satellite imagery to describe how the melt event unfolded, will discuss the role played by El Niño and the SAM, and will draw some comparison with previous major melt events.

Extended Abstracts


(Approaching Willy Field, Antarctica. Photo credit Jonathan Wille)

AMPS Update – June 2016

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1. INTRODUCTION

The Antarctic Mesoscale Prediction System (AMPS) is a real-time, high-resolution, numerical weather prediction (NWP) capability specially configured for Antarctic weather prediction. As sponsored by the National Science Foundation (NSF) Division of Polar Programs, the goals of AMPS include the following:

- To provide real-time NWP guidance for the weather prediction efforts that are vital to the logistics and operations of the U.S. Antarctic Program (USAP). To this end, the AMPS team works closely with USAP weather forecasters to develop new products and enhance AMPS as a tool for Antarctic weather prediction. AMPS has also supported forecasting efforts of various Antarctic field campaigns, with products and grids tailored for the needs of the particular campaign.

- To improve and incorporate model physical parameterizations for the Antarctic, including performing qualitative and quantitative system verification.

- To stimulate collaboration among forecasters, modelers, and researchers by sharing model output and results with the community through the web, an archive, and the annual Antarctic Meteorological Observations, Modeling, and Forecasting Workshop.

The central component of the AMPS project is the real-time NWP forecast, produced twice per day, with graphical and textual products available on the AMPS web page (http://www2.mmm.ucar.edu/rt/amps). AMPS uses the Weather Research and Forecasting Model (WRF), tuned for the Antarctic environment and using adaptations from the Polar WRF effort of the Byrd Polar and Climate Research Center of the Ohio State University.

The primary AMPS forecasts are run on a set of five two-way interactive grids, depicted in Fig.1, with grid spacing ranging from 30 km in the outer grid down to 1.1 km in the innermost grid around Ross Island.

2. RECENT ENHANCEMENTS TO AMPS

With a focus on producing the best real-time forecasts with state-of-the-art tools, AMPS is continually testing and evaluating new software versions and new techniques. Some recent developments are described here.

a. Update to WRF model

Beginning in January 2013, the version of WRF used in AMPS has been WRF-v3.3.1 (released Sep 2011). While the community WRF model has a yearly release cycle, adapting and testing these releases for AMPS can introduce a delay for implementing updated WRF code into AMPS. New versions of WRF do not always result in improved forecasts for AMPS. For example, tests of WRF versions 3.4.1 (released Sep 2012) and 3.5.1 (Sep 2013) showed worse results than 3.3.1, so these versions were not implemented in AMPS. WRF version 3.6.1 (Sep 2014) was at least as good as version 3.3.1, but the increased memory requirements made its use unattractive for

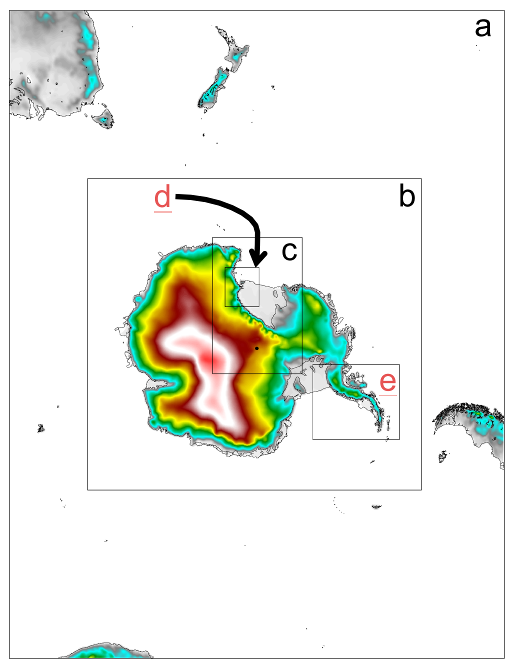

Fig. 1. AMPS grid configuration, with five two-way interactive grids: a) 30-km grid over Antarctica and the Southern Oceans; b) 10-km grid over Antarctica; c) 3.3-km grid over Ross Sea, the Ross Ice Shelf, and the South Pole; d) 1.1-km grid over Ross Island; e) 3.3-km grid over the Antarctic Peninsula.

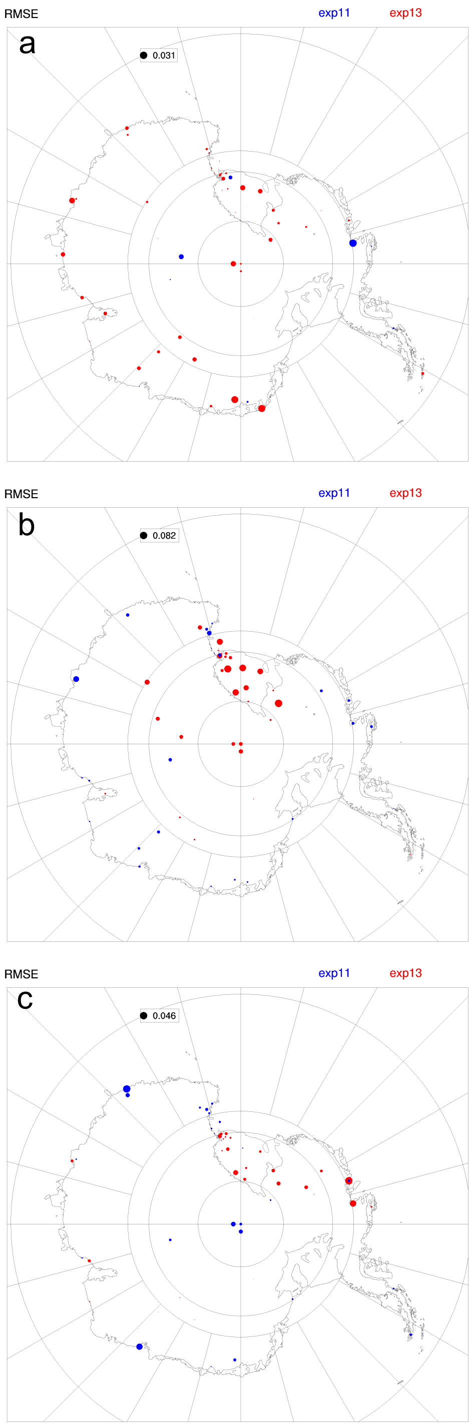

Fig. 2. Comparison of forecast error statistics (RMSE) between WRF-v3.3.1 and WRF-v3.7.1, for Nov-Dec 2015. Red bullets indicate stations at which v3.7.1 have smaller errors than v3.3.1; blue bullets indicate stations at which 3.7.1 have larger errors. Size of the bullet represents magnitude of the difference in RMSE between versions. a) surface pressure RMSE comparison; b) surface temperature RMSE comparison; c) surface wind speed RMSE comparison.

use in AMPS. With concerted effort of the WRF development team at NCAR, memory requirements in version 3.7.1 (Sep 2015) were reduced to levels closer in line with 3.3.1. In tests over Antarctica, model statistics showed smaller errors overall with version 3.7.1, a small but consistent improvement over 3.3.1 (Fig. 2). After further adjustments to mitigate the slower run-time of version 3.7.1, this version was implemented in AMPS in January 2016.

b. AMPS ensemble

The AMPS ensemble, in testing for a few years, has moved from testing phase to become a full component of the AMPS suite of forecast products. This is a small ensemble of about 14 members, suitable for exploratory work, but probably not robust enough to be considered more than experimental. Because of the expense of running multiple instances of the model, the ensemble runs only AMPS domains 1 and 2, in a 30-km/10-km configuration. The ensemble is run after the primary AMPS run; thus at initiation, it is already about 9 hours out of date, and by the time it finishes, the initial hours of the ensemble forecast are 14-15 hours out of date.

A core set of 10 members are initialized from NCEP's Global Ensemble Forecast System (GEFS), while another four to five members are initialized by varying data-assimilation techniques.

One benefit of an ensemble forecast is its capacity to represent forecast uncertainty, that is, to offer forecast probabilities. A single simulation results in a single representation of the atmospheric state; an ensemble of forecasts can encompass a range of possible solutions, given the uncertainty in initial conditions and the limitations of an imperfect model. A wider range of solutions, a greater variation among the solutions, implies greater uncertainty in the predictability of a situation, and perhaps lower confidence in any given solution. To this end, the AMPS ensemble products include a number of probabilistic charts for several forecast parameters. Fig. 3 shows an example of such a chart from the AMPS ensemble.

Ensembles can also help alert forecasters to the potential for extreme events. While one simulation can easily miss an extreme event, an ensemble that represents a wider range of possible outcomes might pick it up. The AMPS ensemble products therefore include a number of charts that plot the minimum or maximum among all the ensemble members for various parameters. An example of such a chart is shown in Fig. 4. The maximum wind speed among all members, for example, will generally be a significant overestimate of winds, but it can help pinpoint regions where a forecaster might want to consider the possibility of strong winds in making a forecast.

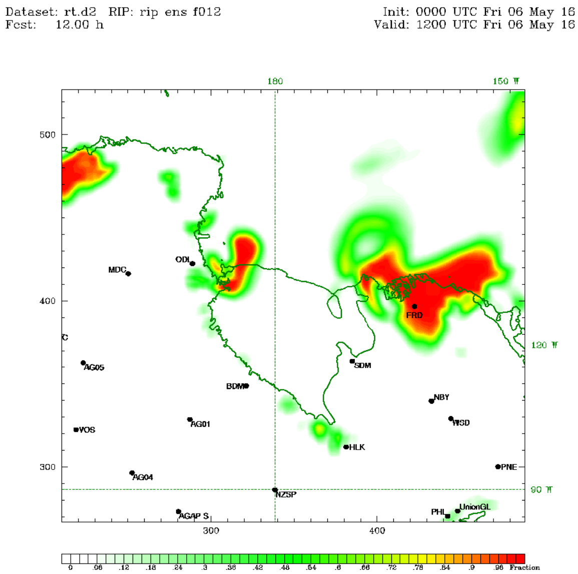

Fig. 3. Example of AMPS Ensemble probabilistic chart, with color fill indicating the fraction of ensemble members with winds exceeding 30 kts.

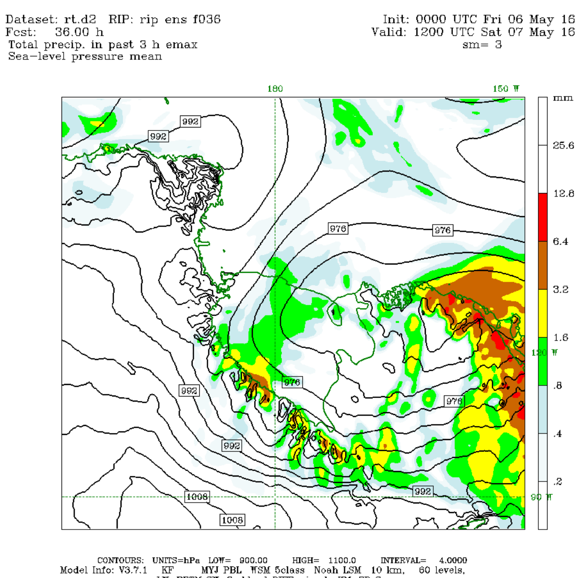

Fig. 4. Example of AMPS Ensemble maximum chart, with shading indicating the maximum 3-hour accumulated precipitation among all ensemble members.

c. Hybrid Ensemble/Variational data assimilation

A side effect of having an AMPS forecast ensemble is that it provides data suitable for employing a "hybrid" data assimilation (DA) approach. Conventional variational DA uses static background error covariance information (updated monthly in AMPS) to represent forecast error. While the strategy of using a static background error is quick and efficient (compared to full ensemble DA), it cannot represent the day-to-day variability of forecast errors. Ensemble DA techniques use an ensemble of forecasts to estimate forecast error for each particular forecast cycle. While the ensemble techniques can reflect predictability differences from day-to-day (i.e., the "flow-dependent" error characteristics of the model), they can quickly get very expensive: typical ensembles run 50 to 100 members, but to adequately represent the parameter space, hundreds of ensemble members may be required. Hybrid DA is a blending of the techniques which can use a less-than-exhaustive ensemble to add flow-dependent error information to the static error covariance statistics.

In AMPS 2-domain tests, forecast errors at the surface (model results compared to surface station data) are largely reduced using the ensemble DA technique, taking advantage of 14 AMPS ensemble members. Comparison of RMSE errors between assimilation techniques is shown in Fig. 5. The DA step for the primary AMPS forecast will likely be switched to use this hybrid technique shortly.

3. UPCOMING CHANGES

a. Increased computing capacity

Since January of 2013, AMPS has been run on a dedicated machine, "Erebus", which is configured as a small sibling to the community "Yellowstone" supercomputer installed at the NCAR-Wyoming Supercomputing Center (NWSC). The Erebus and Yellowstone machines are approaching end-of-life, and a new supercomputer, nicknamed "Cheyenne", is being installed as the next community computing platform for the NWSC. Beginning in 2017, AMPS will run on Cheyenne, and not on a separate machine dedicated to AMPS. While the details of AMPS usage of Cheyenne have yet to be worked out, overall, the resources on Cheyenne may give AMPS roughly 2.5 times the computing resources of Erebus.

4. CONCLUSION

Since 2000, AMPS has been providing USAP forecasters with customized NWP products from dedicated models configured for the unique environment and challenges of Antarctic weather forecasting. With new techniques (such as ensemble forecasts and hybrid data assimilation) and the new resources of the NWSC Cheyenne computer, AMPS is well-positioned to continue to serve the Antarctic forecasting community into the future.

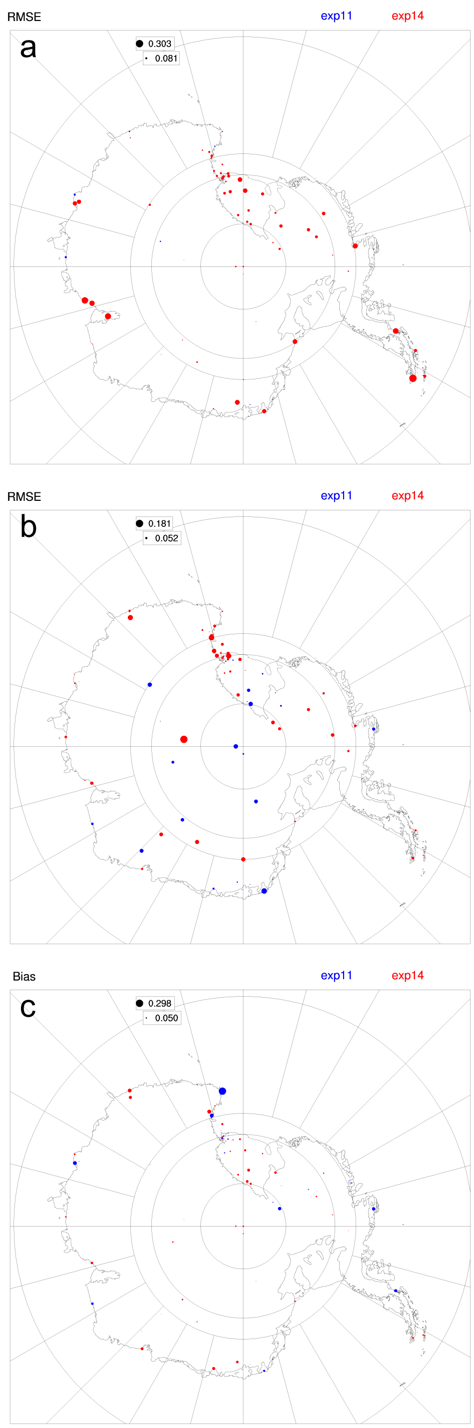

Fig. 5. Comparison of RMSE statistics between conventional and hybrid data assimilation techniques, for Feb-Apr 2016. Red bullets show stations for which the hybrid method reduced the forecast error relative to the conventional method; blue bullets show stations for which the hybrid method increased the forecast error. a) surface pressure statistics; b) surface temperature statistics; c) surface wind speed statistics.

TESTING OF MPAS IN AMPS

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1. INTRODUCTION

The Antarctic Mesoscale Prediction System (AMPS) is a real-time numerical weather prediction capability that provides model guidance for the forecasters of the U.S. Antarctic Program (Powers et al. 2012). AMPS also supports researchers and students, international Antarctic efforts, and field campaigns. Since 2006 AMPS has used the Weather Research and Forecasting (WRF) Model (Skamarock et al. 2008) for its forecasts and products. WRF in AMPS runs with a five-domain nested setup to produce forecasts out to five days and contains polar modifications (see, e.g., Hines and Bromwich 2008) to better capture the characteristics and conditions of the high latitudes.

The Model for Prediction Across Scales (MPAS) is a new numerical weather prediction model designed to simulate from the global to the cloud (i.e., nonhydrostatic) scale (Skamarock et al. 2012). It offers global coverage with a uniform or variable-resolution grid, with the latter achieved via mesh refinement over target regions. Unlike WRF with its regular, rectangular grid approach, MPAS has an unstructured mesh which is built from varied polygons (predominately hexagons). Figure 1 presents an example of an MPAS global, variable-resolution mesh with a finer grid over East Asia. MPAS is the product of a collaboration of NCAR and Los Alamos National Laboratory, and NCAR now supports the MPAS atmospheric model to the community. It has been in public release since 2013, and the current version is 4.0. MPAS has been applied for research (Park et al. 2014) and for real-time forecasting, such as in support of the NOAA Storm Prediction Center's Hazardous Weather Testbed experiment (Clark et al. 2012).

Given MPAS's emergence, the AMPS effort has begun testing of the model in real-time runs over Antarctica. The aims are to gain both experience with this new model in a polar application and an understanding of its behavior and performance. As detailed in Sec. 2, MPAS and WRF runs are configured similarly and forecasts are compared. To date, the model verifications have been limited to austral spring and autumn periods using surface data (Automatic Weather Station (AWS) and surface reports).

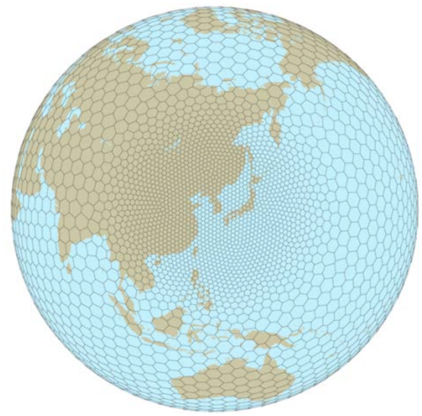


Fig. 1: Example of MPAS variable-resolution mesh. Mesh composed of polygons with higher resolution (finer mesh spacing) seen over center of plotted global domain.

It is stressed that this MPAS testing has just begun, and there are limitations to note. First, in this trial MPAS's configuration is far from WRF's. Given both the state of MPAS development and the restrictions on available computer resources, it is not possible to match either WRF's physics or grids. A second point to note is that WRF has more capabilities for regional modeling than MPAS, and this will be the case for some time. Thus, MPAS will not be the main model used for AMPS any time soon.

2. TEST SETUPS

MPAS was configured similarly to one of the current AMPS ensemble WRF runs, subject to a number of constraints. First, MPAS does not provide for standalone, limited-area domains or nests like WRF: it requires a global grid. Thus, one has to carry, computationally, a mesh over areas beyond the central forecast region. MPAS does allow for regional refinement, however, so that the target area can have finer resolution than the rest of the globe. Here that capability is used to provide a 60-km mesh that decreases to 15 km over Antarctica.

To approximate the WRF setup, the MPAS refined region covers the area of the WRF 10-km domain, shown in Fig. 2. The WRF configuration consists of the 30-km and 10-km domains run operationally. This 30/10 grid was already a member of the basic WRF ensemble running in AMPS and using it avoided additional compute time. Given the available resources, the MPAS refined mesh could not be reduced to 10 km: 15 km was the finest grid practical.

Another necessary difference is the number of vertical levels in each model. The WRF run, as in the regular AMPS forecasts, has 60 half-levels. Because of compute cost, however, the MPAS runs were limited to 45. The model tops are about the same, however. For the height-coordinate MPAS, this is 30 km (~12 mb), while for WRF it is 10 mb (~31 km). Both models were run out to five days from 0000 UTC and 1200 UTC initializations.

To illuminate any seasonal forecast differences, there are two periods of statistical evaluation, austral spring 2015 and fall 2016: 20 Oct–31 Dec 2015 and 8 Feb–31 Mar 2016. AWS data and station reports are used to verify surface temperature, pressure, and wind speed from the forecasts.

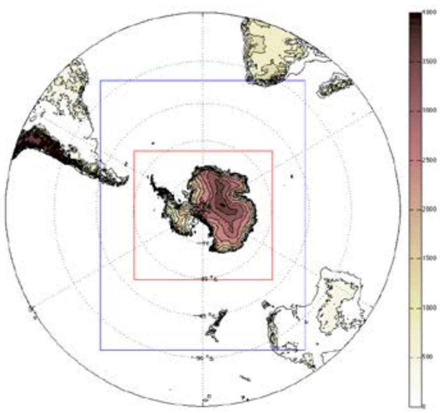


Fig. 2: WRF run domain setup. Outer frame (blue) is the 30-km domain, while inner frame (red) is the 10-km domain. Topography shaded; scale (m) to right.

Both models use the NCEP Global Forecast System (GFS) forecasts as a first-guess and for boundary conditions. However, the WRF run (again, an existing ensemble member) has data assimilation using WRFDA 3DVAR, while no reanalysis is done for the MPAS run.

The suite of physics schemes currently available in MPAS is just a subset of those in WRF. While for some processes the schemes overlap, even with these the versions differ. For example, for WRF (as in AMPS) the schemes are from Version 3.7.1, while the available packages in MPAS are from WRF Versions 3.3–3.5. Table 1 lists the physics options used. The shared packages, are the Noah land surface model, Kain-Fritsch cumulus parameterization, the RRTMG longwave radiation scheme, and the Eta surface layer scheme.

3. RESULTS

a. Forecast Comparisons

The MPAS runs have been subjectively compared to WRF and have been found to be similar overall. Individual forecasts can evolve differently, however, which is not unexpected. Based on an overall review of the MPAS forecasts, it is first found that there are no overtly unphysical results or unusual behavior. In addition, it is noted that MPAS has been computationally robust (i.e., stable).

WRF & MPAS Physics

Shared

- LSM Noah (MPAS V3.3.1, WRF V3.7.1)
- Cumulus Kain-Fritsch (MPAS V3.5, WRF V3.7.1)
- LW radiation RRTMG (MPAS V3.4.1, WRF, V3.7.1)
- Surface layer (Eta) (MPAS V3.5, WRF, V3.7.1)

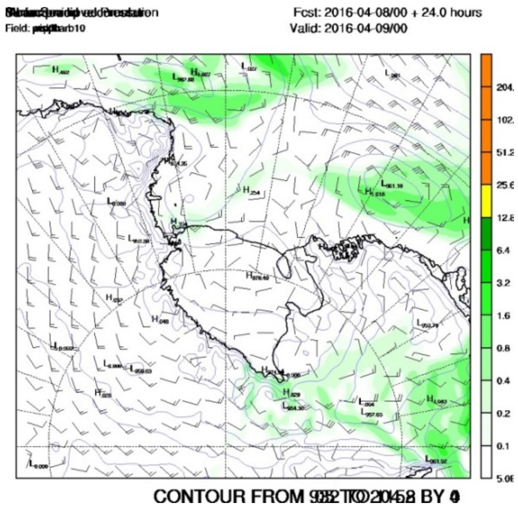
Different

- PBL WRF: MYJ MPAS: YSU
- Microphysics WRF: WSM-5 MPAS: WSM-6
- SW radiation WRF: Goddard MPAS: RRTMG

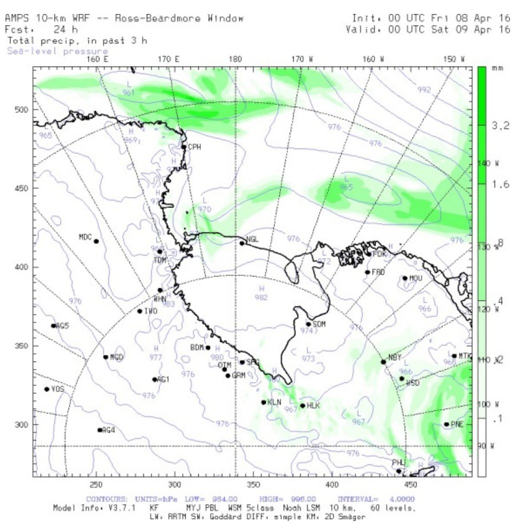
Tab. 1: Physics options used in MPAS and WRF runs. While a number of schemes are the same, the versions of the schemes are not.

As an example of how MPAS and WRF forecasts can compare, one case is selected here. While AMPS WRF forecasts have been scrutinized for years, MPAS is an unknown over Antarctica. Thus, one aim is to see whether MPAS does anything unusual compared to a quasi-benchmark WRF forecast.

Figures 3 and 4 show the MPAS and WRF forecasts from 0000 UTC 8 April 2016. At hour 24, the MPAS (Fig. 3(a)) and WRF (Fig. 3(b)) SLP and 3-hourly precipitation fields in the Ross-Beardmore sector are similar. The noteworthy feature is the deep low in the Ross Sea off Marie Byrd Land. Both the placement and central pressure are aligned at this time: the MPAS low is at 961 mb and the WRF low is at 965 mb. Compared with the AMPS analysis for this time (0000 UTC 9 April 2016) (not shown), both runs are accurate, with the analyzed low depth at 963 mb. It is found that the forecast WRF center, however, which is slightly west of the MPAS center, is a little closer to that of the analysis.



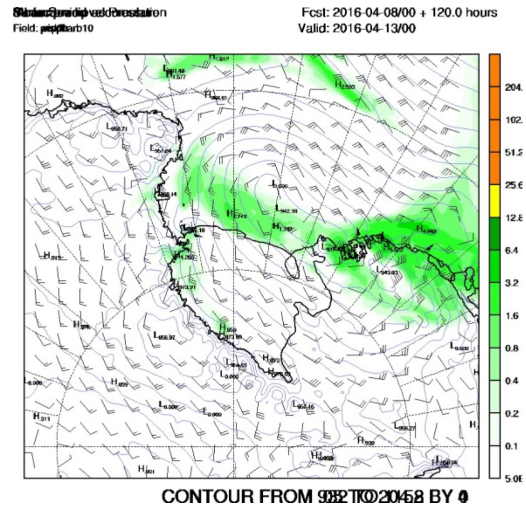
(a)



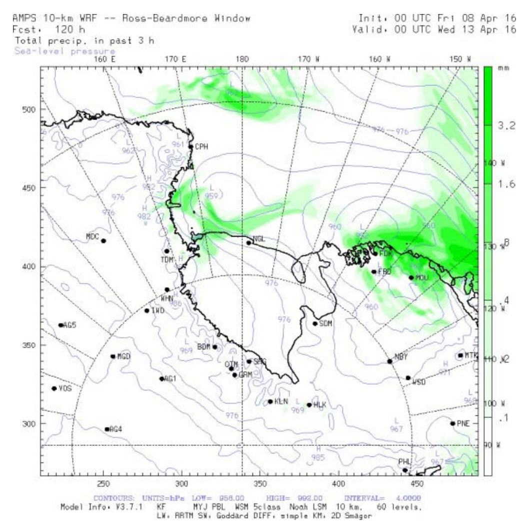
(b)

Fig. 3: MPAS and WRF 24-hr forecasts for 0000 UTC 9 April 2016 (0000 UTC 8 April initialization). Sea level pressure (solid, interval= 4 mb) and 3-hourly precipitation (mm, scales to right) shown. (a) MPAS. Wind barbs: full barb= 10 kts. (b) WRF.

By hour 120, however, the simulations have diverged (Fig. 3). WRF (Fig. 3(b)) has developed two distinct low centers, one off Marie Byrd Land (952 mb) and one in the western Ross sea (959 mb). In contrast, MPAS (Fig. 3(a)) has a single, elongated trough through the southern Ross Sea with a deeper minimum pressure of 942 mb. The AMPS analysis for this time (Fig. 3(c)) indicates that MPAS verifies better than WRF, with its two centers.



(a)



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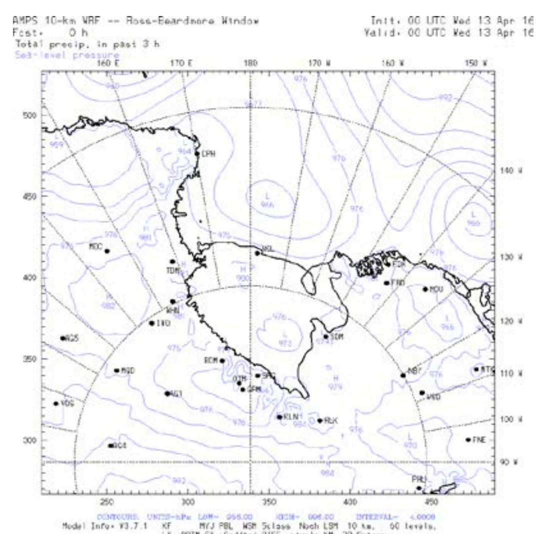
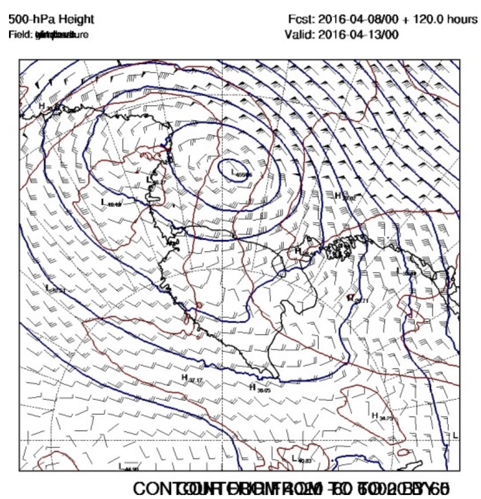


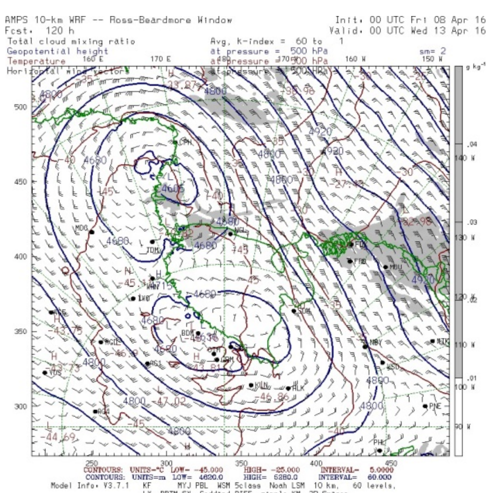
(c)

Fig. 4: MPAS and WRF 120-hr forecasts for 0000 UTC 13 April 2016 (0000 UTC 8 April initialization) and analysis. Sea level pressure (solid, interval= 4 mb) and 3-hourly precipitation (mm, scales to right) shown. (a) MPAS. Wind barbs: full barb= 10 kts. (b) WRF. (c) AMPS analysis for 0000 UTC 13 April 2016.

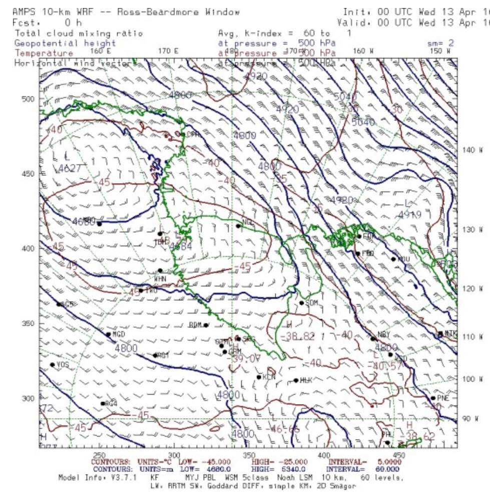
These surface development differences reflect differences aloft. Figures 5(a) and 5(b) show the MPAS and WRF 500 mb forecasts for this time (hr 120). While MPAS has a single 500 mb cutoff circulation, WRF has produced two centers at this level. Based on the analysis (Fig. 5(c)), the single center in MPAS is a better representation, but the positioning of the overall WRF trough, more to the west than in MPAS, shows less position error; the MPAS 500 mb cutoff low sits more eastward of the analyzed position over Victoria Land.



(a)



(b)

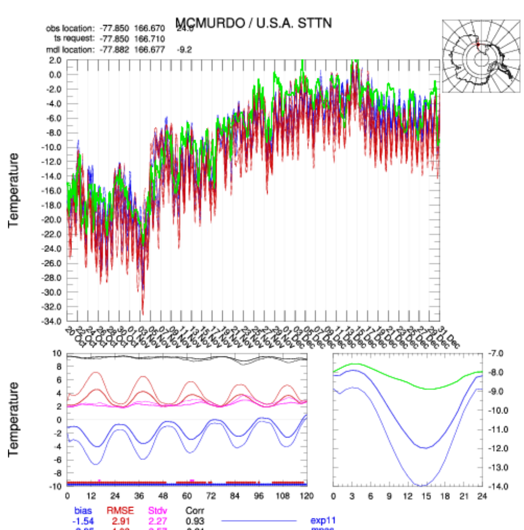


(c)

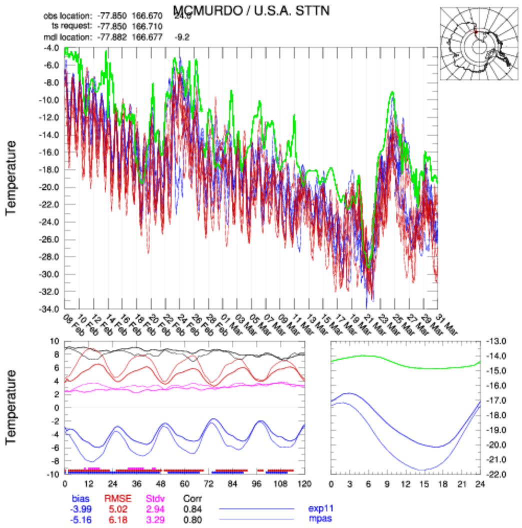
Fig. 5: MPAS and WRF 120-hr 500 mb forecasts for 0000 UTC 13 April 2016 (0000 UTC 8 April initialization) and analysis. Heights solid (m, blue, interval= 60 m), winds (full barb= 10 kt) and temperature (red) (C, interval= 5C). (a) MPAS. (b) WRF. (c) AMPS analysis for 000 UTC 13 April 2016.

b. Verification Statistics

Statistical verifications have been performed for the test periods for surface temperature, pressure, and wind speed. The verification uses AWS and surface station data from approximately 50 sites. Significance testing has been done on the differences between the error statistics for the models.



(a)

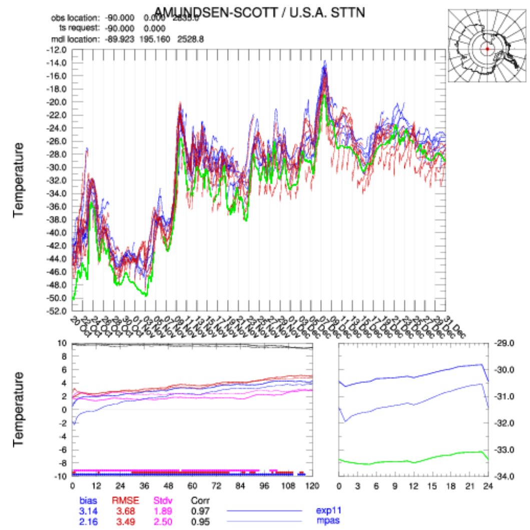


(b)

Fig. 6: Surface temperature forecasts and error statistics for MPAS and WRF at McMurdo. Top panel: Observations (green), MPAS forecast (red) temperatures, and WRF forecast (blue) temperatures. Bottom left: Average errors per forecast hour (hrs 0–120)— WRF thick solid, MPAS thin solid. Blue= bias; red= RMSE; pink= bias-corrected RMSE; black= correlation. Dots in a given color indicate that the error differences for the corresponding statistic for the given forecast hour are statistically significant. Bottom right: Average biases (°C) for a 24-hr diurnal period. (a) Oct.–Dec. 2015. (b) Feb.–Mar. 2016.

Figure 6 shows the temperature statistics for McMurdo for the Oct.–Dec. 2015 (Fig. 6(a)) and Feb.–Mar 2016 (Fig. 6(b)) periods. The top panel presents the MPAS (red) and WRF (blue) forecasts, along with the observations (green). The lower left panel shows the model bias (blue), RMSE (red), bias-corrected RMSE ("Stdv"; pink), and correlation coefficient (black) averaged over the 120-hr forecast periods. WRF results are in the thick curves and MPAS results in the thin curves. The statistical significance of the differences in the metric between the two runs at the 95% level is indicated by colored dots for the given hour along the bottom axis. Lastly, the lower right panel presents the average forecast and observed temperatures over the diurnal cycle, with MPAS and WRF the thin and thick traces, as in the lower right. For these diurnal view panels, only the model 0000 UTC runs have been used. The value for a given model hour reflects the averaged model forecast temperatures verifying for that local hour. Thus, for hour 12 it represents that day's 0000 UTC forecast for hour 12, plus the previous day's forecast for hour 36, etc.

For McMurdo the top panels reveal that the MPAS forecasts are, on the whole, colder than the WRF forecasts, which translates to an increase in the cold bias here. Throughout the forecasts there is a larger cold bias for MPAS at McMurdo for both seasons. The average bias (i.e., for both periods, as shown in lower left panel) for WRF is -2.8C, while for MPAS it is -4.0C. This larger temperature bias for MPAS is significant for almost all forecast hours.



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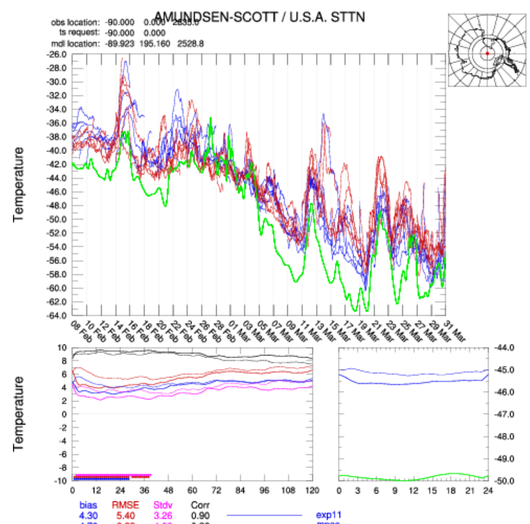


(b)

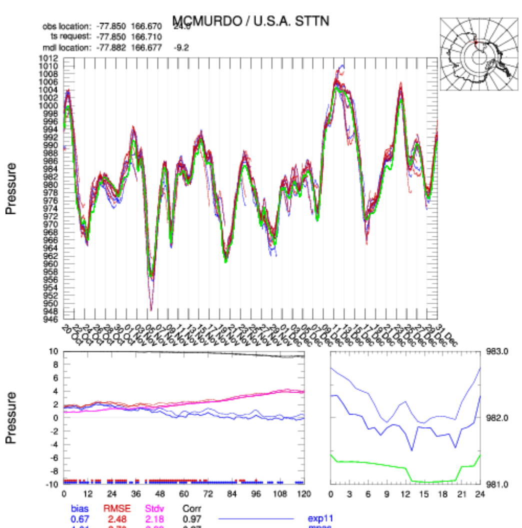
Fig. 7: Surface temperature forecasts and error statistics for MPAS and WRF at South Pole. Panels as in Fig. 5. (a) Oct.–Dec. 2015. (b) Feb.–Mar. 2016.

Figure 7 shows the temperature results for South Pole. MPAS (Fig. 7(a)) for Oct.–Dec. has less of a warm bias than WRF (Fig. 7(b)), which has always displayed a warm bias at this key location. The

MPAS bias decreases to 2.2C from WRF's 3.1C, and the bias differences are significant for virtually the entire 120-hr period. For Feb.–Mar. WRF has a lesser warm bias than MPAS, but the differences are smaller and not significant in the forecasts after hour 36.

Errors in surface pressure and winds have also been calculated and compared. Figure 8 shows the pressure results for McMurdo. First, note that the forecast traces for both models for both periods (Fig. 8, top panels) track the observations well. The correlations for both models average .96. For Oct–Dec., WRF shows an improvement over WRF in bias, with a statistically significant reduction through hour 72 of .3 mb, from 1.0 mb to .7 mb (Fig. 8(a), lower left). For Feb.–Mar., the differences are small, with MPAS being slightly better (a .2 mb reduction) (Fig. 8(b), lower left and right).

Illustrating wind speed results, Fig. 9 presents the statistics for South Pole. Here WRF shows clear and statistically significant improvements in both bias and RMSE. The overall (i.e., averaging both seasons) bias is +0.5 ms^{-1} for WRF and -1.6 ms^{-1} for MPAS, with corresponding RMSEs being 1.7 ms^{-1} and 2.3 ms^{-1}.



(a)

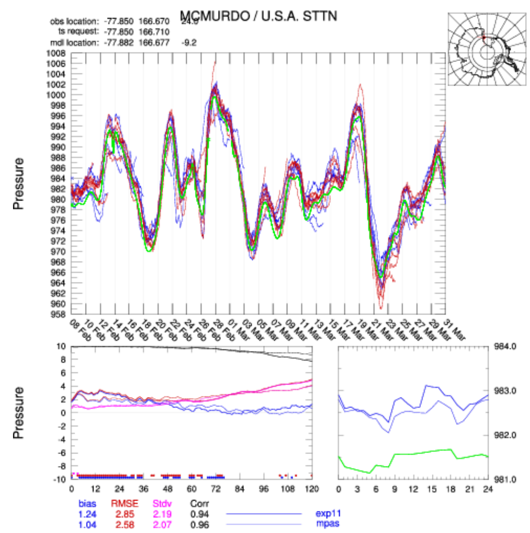


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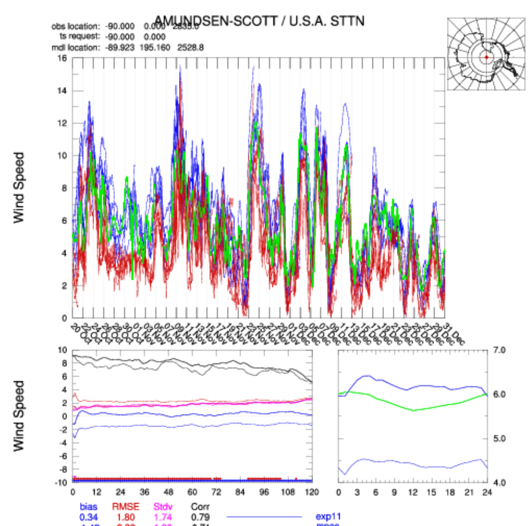
Fig. 8: Surface pressure forecasts and error statistics for MPAS and WRF at McMurdo. Panels as in Fig. 5. (a) Oct.–Dec. 2015. (b) Feb.–Mar. 2016.



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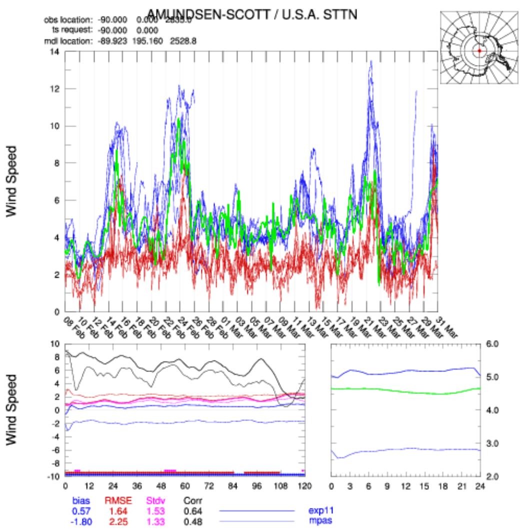
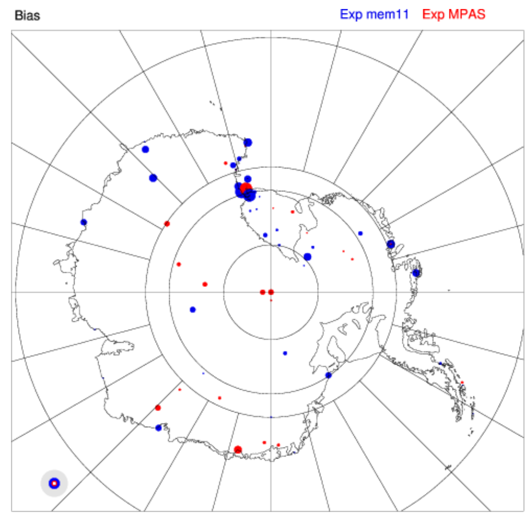


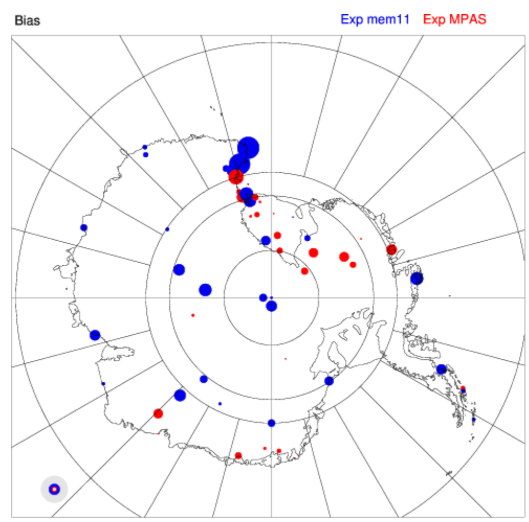
(b)

Fig. 9: Surface wind speed forecasts and error statistics for MPAS and WRF at South Pole. Panels as in Fig. 5. (a) Oct.–Dec. 2015. (b) Feb.–Mar. 2016.

As exemplified in the comparisons of pressure at McMurdo and wind at South Pole, the results vary with parameter and station. WRF overall has lower errors in the selected surface parameters across sites, but it does not always outperform MPAS. The results in Figs. 10–12 illustrate this mix. Here the circle color indicates which run is better at the given site, and the circle size is proportional to the magnitude of the improvement. For surface temperature, the results are mixed for Oct.–Dec. (Fig. 10(a)), while WRF is better for Feb.–Mar (Fig. 10(b)). Conversely, for surface wind speed, the results are mixed for fall (Fig. 11(b)), while MPAS has an edge in the spring (Fig. 11(a)). Lastly, for surface pressure, WRF is better overall for both the spring and fall periods (Figs. 12(a),(b)). As for the forecast temperature correlations with observations, there is little difference between the runs.

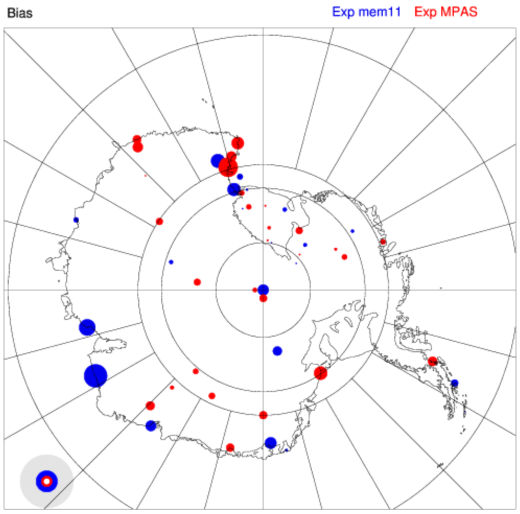


(a)



(b)

Fig. 10: Comparison of surface temperature biases for MPAS and WRF. Red= MPAS better; blue= WRF better. Circle size proportional to magnitude of improvement. (a) Oct.–Dec. 2015. (b) Feb.–Mar. 2016.



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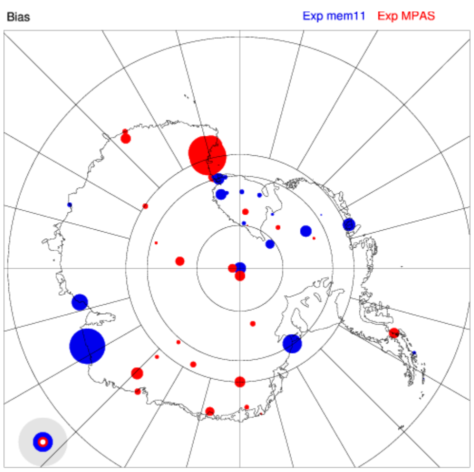


(b)

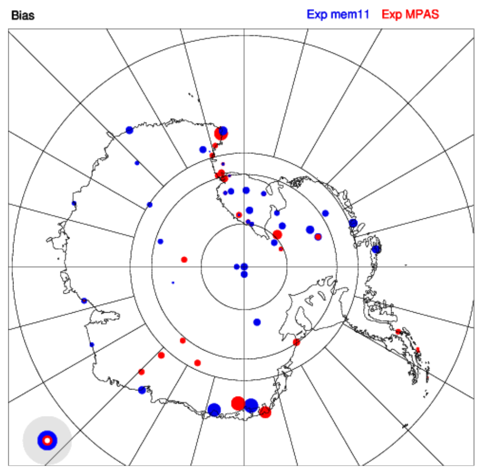
Fig. 11: Comparison of surface wind biases for MPAS and WRF. Red= MPAS better; blue= WRF better. Circle size proportional to magnitude of improvement. (a) Oct.–Dec. 2015. (b) Feb.–Mar. 2016.

4. SUMMARY AND CONCLUSIONS

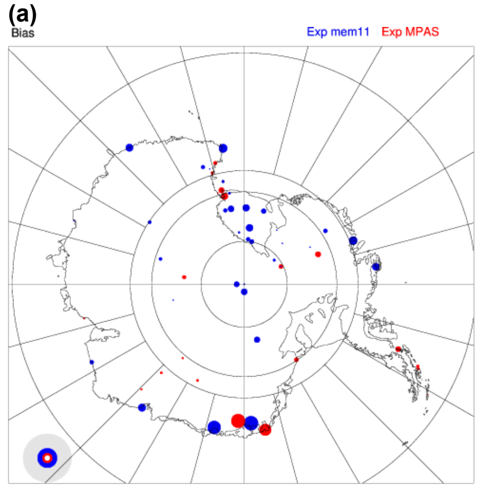
The Model for Prediction Across Scales (MPAS) is an emerging global model that is designed to operate accurately down to nonhydrostatic scales. Supported by NCAR, it has been in public release since 2013 and is being applied for both research and real-time forecasting. While it only runs as a global model now, MPAS can provide mesh refinements over regions of interest. In light of MPAS's development, the AMPS effort has begun testing it over Antarctica, and this investigation is the first detailed look at MPAS over a polar region.

This study looks at MPAS and WRF forecasts from similar, but not identical, configurations for both austral spring and fall periods. Forecasts are subjectively and objectively verified, with the latter review consisting of evaluations of surface parameters at mostly AWS sites. Limitations both on compute resources and on the physics options in MPAS have made for test runs that, while similarly configured, are not identical. This is the most basic caveat for this first comparison of the models.

From a subjective look at the forecasts, it is found that MPAS behaves consistently with WRF and does not display any gross discrepancies on a regular basis. In addition, MPAS has not presented any operational problems or displayed noticeably unphysical results.



(a)



(b)

Fig. 12: Comparison of surface pressure biases for MPAS and WRF. Red= MPAS better; blue= WRF better. Circle size proportional to magnitude of improvement. (a) Oct.–Dec. 2015. (b) Feb.–Mar. 2016.

While only a limited sample can be presented here, from the surface verifications for all sites it is found that overall WRF performs better statistically than MPAS for the test periods. Surface temperature and pressure forecasts are overall better (RMSE, bias) across the continent for WRF. However, even with its coarser configuration, MPAS holds its own and shows statistically better performance at many sites for given variables. And, the results for the models for a given site and variable can vary with the season considered: better performance in one season does not necessarily carry to the other.

Although there is no big dropoff in forecast performance with MPAS compared to WRF, even with MPAS being run on a coarser grid and without polar-modified physics, it is emphasized that full MPAS use in AMPS will not occur soon. First, MPAS is much more expensive computationally. To run a 10-km Antarctic refinement in MPAS would be about 6X the cost of the 30-km/10-km WRF run. Second, MPAS's physics options are limited and lack current polar modifications. Third, data assimilation for MPAS has not been developed. Fourth, and most importantly, more basic testing and verification of MPAS over Antarctica (e.g., longer periods, upper-air analysis) are necessary to better understand its performance and potential issues. Nonetheless, the active development of MPAS means that its use and capabilities will only grow. It will continue to be run within the AMPS framework from now on.

ACKNOWLEDGEMENTS

The authors thank the NSF Division of Polar Programs for its support of AMPS.

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THE UW-MADISON 2015-2016 ANTARCTIC AUTOMATIC WEATHER STATION PROGRAM FIELD SEASON: FIXING AWS FROM McMURDO TO WEST ANTARCTICA

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http://amrc.ssec.wisc.edu/

1. OVERVIEW

The University of Wisconsin-Madison (UW-Madison) has overseen the Antarctic Automatic Weather Station (AWS) network since 1980. The AWS network consists of approximately 60 AWS (Figure 1). In this final year of the current AWS grant, two separate field teams visited a total of 26 AWS sites to service, replace, remove, or install AWS. David Mikolajczyk (UW-Madison) and Mark Seefeldt from the University of Colorado-Boulder (UC-Boulder) were on the ice from October through December 2015. Lee Welhouse and Carol Costanza (both from UW-Madison) were on the ice from December 2015 through February 2016. Highlights from this field season include completing the conversion of Cape Hallett AWS transmissions from Argos to Iridium, as well as installing two new AWS in West Antarctica. Overall, the 2015-2016 field season was successful with extensive work completed from McMurdo and West Antarctica Ice Sheet-Divide field camp.

2. FIRST HALF OF THE FIELD SEASON

David and Mark arrived in Antarctica on 21 October 2015. Their first AWS visit was to Cape Hallett AWS on 26 October, where the AWS transmissions were switched from Argos to Iridium. Due to the numerous instruments and subsequently large amount of data collected at Cape Hallett AWS, Iridium is a better option because it allows more data to be transmitted.

They continued to do field work out of McMurdo through November, including helicopter flights to White Island, Ferrell, and Linda AWS and Twin Otter flights to AWS sites on the Ross Ice Shelf. The original schedule called for Dave and Mark to go to WAIS on 21 November but that was delayed until 1 December. Even during the delay, they were still able to complete field work out of McMurdo, which is a testament to the flight operations coordinators' hard work and diligent efforts.

Once at WAIS, Dave and Mark serviced numerous AWS, including Evans Knoll and Thurston Island, which hadn't been visited since their initial installs in 2011. They removed Brianna AWS on 9 December, which hadn't been visited since 2002 and had been planned for removal for many years. Due to its proximity to a crevasse field, it was deemed unsafe to land until satellite imagery acquired on the ice this year from the Polar Geospatial Center (PGC) showed us that landing there was a possibility. On 12 December, Dave and Mark completed a new

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station install, Austin AWS, located in Ellsworth Land.

3. SECOND HALF OF THE FIELD SEASON

Lee and Carol arrived in Antarctica on 29 December 2015. Their first objective was to go to WAIS to finish the servicing in West Antarctica. They were also delayed 10 days getting to WAIS, but during their delay they were not able to complete other field work during the busier summer season in early January. Once they made it to WAIS they were very successful. On 18 January, Lee and Carol also completed a new install, Kathie AWS, also in Ellsworth Land.

From McMurdo, Lee and Carol finished up almost all of the scheduled field work for this field season. On 26 and 27 January, they moved Siple Dome AWS closer to the Siple Field Camp. On 5 February, they removed Nascent AWS, which had been in the field but out of commission for several years.

4. COLLABORATING FIELD WORK

Two new AWS, Gerlache Strait and Neko Harbor, were installed on the peninsula in collaboration with a fjord ecology project out of Scripps Research Institute. The French Antarctic Program visited D-10, D-47, D-85 and Dome C II AWS. Additionally, they serviced Port Martin AWS and got it back online.

5. ACKNOWLEDGEMENTS

The authors wish to thank the NSF, ASC, PHI, Ken Borek Air, PGC, IPEV, NYANG, USAF, and others within the USAP for their support of this field season's efforts. This material is based upon the work supported by the National Science Foundation grant number ANT-1245663. Scripps AWS material is supported by PO 91058317.

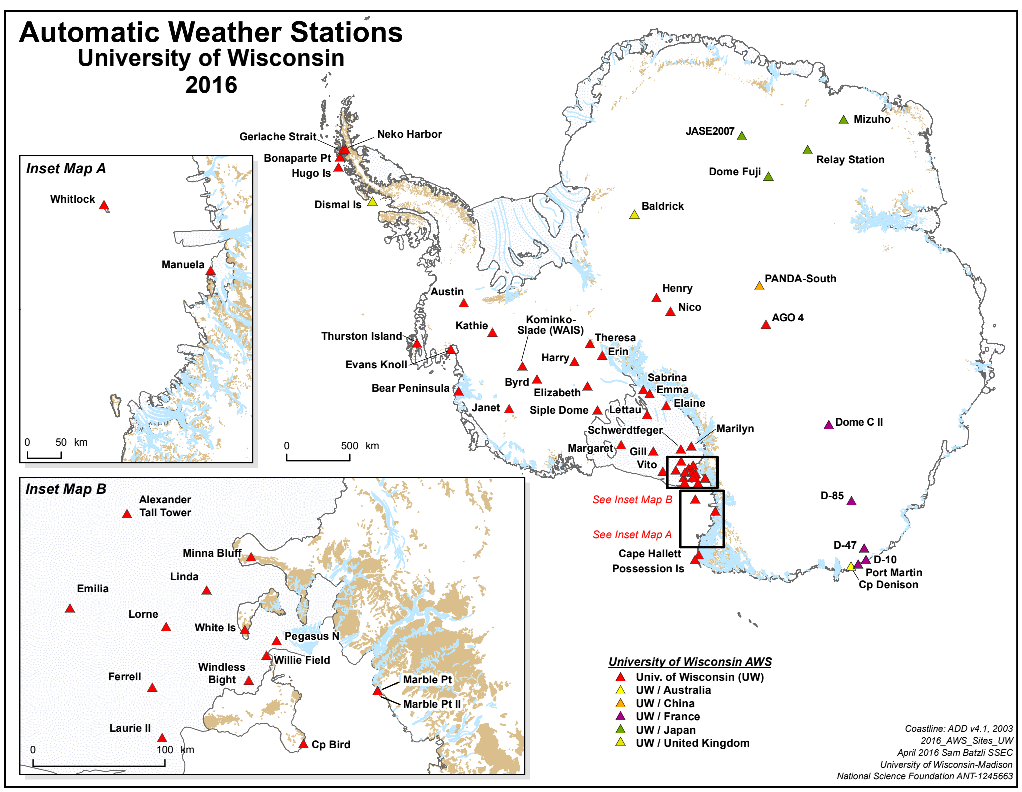

Figure1: A map of UW-Madison AWS, as of the end of this past 2015-2016 field season.

Antarctic Peninsula Automatic Weather Station Network
2015-16 Field Season Review

Rosey Grant[1], Steve Colwell, John Law, Mairi Simms
British Antarctic Survey

1. Overview

The British Antarctic Survey (BAS) currently runs a network of nine automatic weather stations (AWS) located on the Antarctic Peninsula and in the Halley region. Through an ongoing collaboration with the University of Utrecht, BAS is also responsible for the servicing of a small network of AWS on the Larsen ice shelf. AWS locations are shown in figure 1.

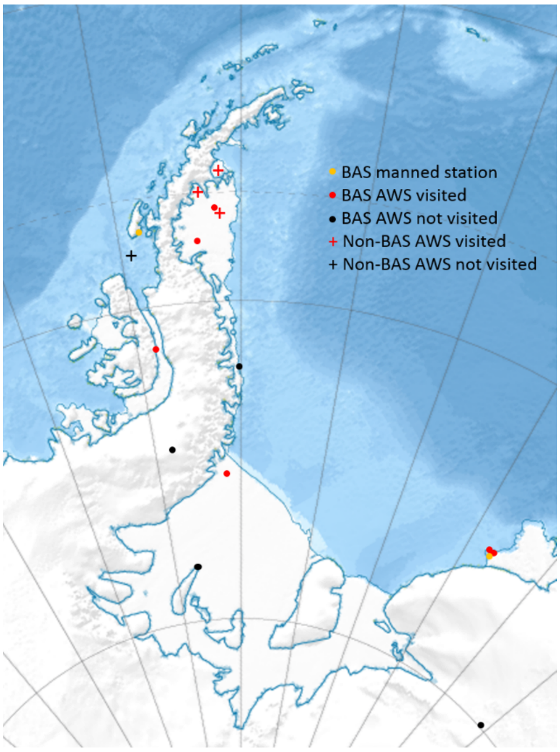

Figure 1: Peninsula and Brunt ice shelf AWS

All BAS stations measure wind speed, wind direction, temperature, pressure and relative humidity. Data is logged to a Campbell Scientific CR1000 data logger and ten minute averaged data is saved to a data card. Ten minute averaged data are transmitted via SBD Iridium every three hours and relayed as SYNOPS on the GTS. Once a week the complete data set is sent via Iridium. The AWS are powered by 100Ah 12V lead acid batteries, charged by solar panel. Assuming normal service, these stations need only be visited to raise the instruments above snow accumulation and to retrieve and replace data cards. Visits usually take place every one or two years.

2. 2015-16 season

This season six of the nine BAS sites were visited for data retrieval and instrument raising.

All the University of Utrecht sites were successfully visited.

The AWS at Dismal Island (50km south of Rothera) belongs to the University of Wisconsin. It has not been visited since 2009 and is no longer working. The University of Wisconsin provided a complete new station to be installed at this site in 2014-15. The service was to happen from the RRS Ernest Shackleton at the end of the 2014-15 season but the trip was cancelled due to time constraints. Despite several attempts again this season, bad weather made it impossible to land on the island. The station remains at Rothera, ready for another attempt next season.

3. Issues encountered

Over the last two seasons it has been observed that several of the data cards

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retrieved from the BAS AWS were unreadable. The card readers at each site were replaced during the 2014-15 season. This did not solve the problem. Campbell recommended updating the operating system of the loggers. This was attempted at two sites. At the first site the upgrade was successful. At the second site (Larsen) the upgrade rendered the logger completely unresponsive. Sadly the AWS had to be left in this state so is currently not logging at all. No further OS upgrades were attempted. It has further been suggested that the old OS may not be able to write to new, large memory cards. Next season we will ensure that only 256MG cards are used.

4. Intentions for 2016-17 season

As always, this field season will see operations based from Rothera and Halley.

- The Larsen AWS has not been logging since the OS upgrade attempt in January. This AWS is co-located with one of the University of Utrecht AWS so the BAS station will be removed next season.
- The power system at Limbert is not working so a visit to this site will be the priority at the start of the season.
- Both the Korff site and the South Larsen site have not been raised since the 2013-14 season so they must be raised next season or risk getting buried.
- A third request to visit Dismal Island will be submitted.

All other AWS are currently working well so no other site visits are currently planned.

5. Are the RM Young Heavy Duty Wind Monitor-HD-Alpine worth the extra $338?

BAS AWS use the RM Young Heavy Duty Wind Monitor-HD. Recently Young have produced an Alpine version of this wind monitor, “coated with a specially formulated, ice resistant coating to improve performance in harsh Alpine conditions. The all-black color scheme further enhances the ice shedding performance of the sensor.”[2] Both models have been mounted side by side at Halley for three months. Is the Alpine version worth the extra $338? Data and photographs from this period will be presented.

Figure 2. Top: RM Young Heavy Duty Wind Monitor-HD (left) and RM Young Heavy Duty Wind Monitor-HD-Alpine (right). Bottom: Non-Alpine (left) and Alpine (right) version mounted at Halley during the same riming event.

6. Future improvements to the BAS AWS

With an increasing number of remote instruments to service, BAS is looking to make every site visit as efficient as possible. Over the coming months we will be considering ways to improve the BAS AWS, with the aim of installing a new trial system at Rothera during the 2016-17 season.

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[2]http://www.youngusa.com/products/7/68.html

ANTARCTIC CYBERINFRASTRUCTURE: A PATH TO SUSTAINABILITY

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1. OVERVIEW

The Antarctic Meteorological Research Center (AMRC) has been collecting and providing a unique dataset of Antarctic meteorological data for over 24 years. As of 2015, the AMRC (the grant, not the name of the research group) is no longer funded by the National Science Foundation (NSF). In the wake of this, a unique opportunity has been afforded to the US Antarctic meteorological community: to define a pathway to a sustainable Antarctic meteorological cyberinfrastructure. Any recommendations will come from input by those in the Antarctic meteorological science community of the United States Antarctic Program (USAP). This input will be largely provided by the Antarctic Meteorological Cyberinfrastructure Task Force. In the meantime, there has been a continued effort to maintain a minimum level of the existing data infrastructure that the AMRC has historically been known for during this short effort.

2. TASK FORCE

On Thursday, June 9th, 2016 a committee of members from the Antarctic community will meet in person to discuss what a sustainable future might be like for the USAP meteorological community. The task force committee includes those in Table 1.
Information security, estimates of costs, potential hosts for the data, sustainable funding, data visualization, and levels of security are only a few of several requirements that will be considered in making the recommendations.

Table 1: Antarctic Meteorological Cyberinfrastructure Task Force members and affiliations.

Member	Affiliation
David Bromwich	The Ohio State University
Michael Carmody	Antarctic Support Contract
Arthur Cayette	SPAWAR/SOPP
Jim Frodge	SPAWAR/SOPP
Dan Lubin	University of California, San Diego
Kevin Manning	National Center for Atmospheric Research
Jonathan Pundsack	Polar Geospatial Center

The task force will also consider the future of how data such as South Pole's surface observations or McMurdo's radiosonde observations will flow from data source to final archive, researchers, forecasters and educators alike. Ultimately, the task force will outline the expectations for the Antarctic meteorological data needs along with the qualities of the stewardship of that meteorological data by writing a report of recommendations to the NSF, Division of Polar Programs (PLR). A sample of guiding questions includes:

- Where does the repository reside? With the government? With a contractor? With an educational and/or non-profit entity?

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- What level of information security issues need to be addressed that will enable the multi-user USAP community to participate in both roles as data providers and data users?

- What will the data path(s) be for both operational data and research science data? Will these paths fit well with NSF required data management plans, etc. outlined by proposing science projects, or are those a part of standard operating procedures of base operational meteorological collections?

- The task force can address other questions and concerns, as they deem appropriate.

Another major topic that will be discussed by this group includes the future evolution of the community-wide research and development project, the Antarctic-Internet Data Distribution (Ant-IDD) system that utilizes NSF's Unidata project's Local Data Manager (LDM) system. This system will have significant change with the USAP contractor, Antarctic Support Contract (ASC) taking over the role of Ant-IDD data-relay to and from Antarctica. It also affords the opportunity for this system to become operationally supported and offer more network stability, pending community use and interest.

It is important to denote that future real-time meteorological data activities that have been a historic part of the AMRC are in flux. Some real-time efforts are ongoing, thanks to support from Scientific Research Corporation/SPAWAR Office of Polar Programs and the Antarctic Infrastructure and Logistics section of the NSF. For example, funding for the availability of real-time Automatic Weather Station observations (AWS) is only funded through September 2016. The Antarctic satellite composite imagery, a hallmark of the AMRC, future is also uncertain after this date as well, as funding is very limited. Discussions to have a branch of the National Oceanic and Atmospheric Administration (NOAA) request the composite (and thus have NOAA generate the composite) have not yet secured a viable path, yet. The Ocean Prediction Center has declined requesting the Antarctic composites at this time, while the National Ice Center is considering it, but has not committed to it. Without another external funding source or adoptor, the future of the composites will rest with the Director of the Space Science and Engineering Center, where the AMRC is housed in at UW-Madison.

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3. INPUT OPPORTUNITY

Recommendations from all in attendance at the Antarctic Meteorological Observation, Modeling, and Forecasting Workshop (AMOMFW) will be considered. The 11th AMOMFW provides an initial opportunity for the community to provide direct feedback, thoughts, and ideas to the task force while the Task Force prepares to writes the report due to the NSF on or before 31 August 2017. The Task Force may seek additional input in the coming weeks and months. They may welcome unsolicited input as well.

4. ACKNOWLEDGEMENTS

This material is based upon the work supported by the National Science Foundation grant number ANT-1535632.

HETEROGENEOUS AND HOMOGENEOUS OBSERVING NETWORKS: THE NEXT CHALLENGE FOR ANTARCTICA

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1. OVERVIEW

The Antarctic's most extensive observing system is the Antarctic Automatic Weather Station network. With over 120 locations (more including other ancillary systems that also observe some basic weather measurements), it is the only network to span the whole continent. Combined with staffed observing station; the surface meteorological network across the Antarctic is crucial for operational and logistical safety for day-to-day activities in the Antarctic and our longest running source of surface climatology. One of the many challenges faced by the network is observing strategy. While this has been a topic of discussion in prior Antarctic Meteorological Observation, Modeling and Forecasting Workshops (AMOMFW) (e.g. Weidner, 2008), future research will likely depend on observations made today.

2. HETEROGENEOUS VS HOMOGENEOUS

The sampling schemes currently in use across the Antarctic vary dramatically. Historically the Wisconsin AWS 2B network had a standard of instantaneous sampling every 10 minutes. Today, with modern robust data logging systems, sample methods have increase dramatically, enabling a variety of user defined schemes. Hence, some AWS networks in the Antarctic have 10-minute averaging. Some research projects have used a 5 minute averaging window or even as much as a 30-minute averaging window! Beyond this, staff station systems have their own schemes. A non-scientific sample of surface observing systems reveals few, if any, of these networks or surface observing sites are following established World Meteorological Organization sampling schemes (e.g. WMO publication, #8 Part II, Chapter 1, circa 2012). Thus, the Antarctic meteorological surface observational system is a heterogeneous network. A homogeneous network is one that has the same observing and sampling strategy across the network.

3. THE CHALLENGE

This presentation is inspired by recent work (Cao and Fovell, 2016) that looked at numerical model of wind events and observations by a surface-observing network. The crucial research depended on a homogeneous observing network. Can the international Antarctic meteorological community work toward a common goal of having a standard observing scheme? This presentation will outline the future plans for the WMO inspired scheme that the Wisconsin AWS network plans to implement based on work in progress from Alexander Tall Tower! AWS observations.

5. ACKNOWLEDGEMENTS

This material is based upon the work supported by the National Science Foundation grant number ANT-1245663.

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AMPS AND HENRY AWS ANALYSIS 2009 TO 2015

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1. OVERVIEW

The Antarctic Mesoscale Prediction System (AMPS) is a polar version of the Weather Research and Forecasting (WRF) model, that is used by Antarctic weather forecasters. There have been many different versions of AMPS over the past decade to improve forecasts over Antarctica. The Antarctic Automatic Weather Station (AWS) project maintains sites on the Ross Ice Shelf, West Antarctica, and South Pole, which are often used to verify model output. After visiting Henry AWS, near the South Pole, in January of 2015 there was motivation to get a better understanding of the differences in the measurements between Henry AWS and the AMPS model. Thus a seven-year analysis (2009-2015) was done by matching a time period when Henry AWS data was available during the AMPS WRF era.

2. METHODS

Four parameters were chosen in this analysis. AWS temperature was compared with the AMPS two-meter temperature field, and AWS pressure was compared with the AMPS station pressure. For wind, AWS resultant wind speed was compared with calculated resultant wind from AMPS u and v components at 10 meters. The AWS resultant wind direction was compared with AMPS u and v components at 10 meters using trigonometry to get the wind direction. Three-hourly AWS observations were compared with the three-hourly AMPS forecasts from the daily 00 UTC forecast model. The grid point closest to Henry AWS was used in all cases, and there was no interpolation done between grid points.

3. DISCUSSION

The bias and difference between Henry AWS measurements and AMPS forecasts have changed throughout 2009-2015. Over the course of the seven-year period, temperature goes from a warm bias to a cold bias. Station pressure has a consistent bias of about + 5 hPa, wind speed is ranging from +1 to +0.5 m/s except for 2015 which is + 3.3 m/s. The wind direction bias is changing throughout the years. 2015 is anomalous because the bias in AMPS gets larger not smaller from 2014 to 2015 in almost all of the parameters (Figure 1). This might be due to the change in instrument at Henry AWS that occurred in January of 2015. This highlights the importance of cooperation between changes in observational networks and users such as numerical modelers.

4. ACKNOWLEDGEMENTS

The authors appreciate the support of the University of Wisconsin-Madison Automatic Weather Station Program for the data set, data display, and information, NSF grant number ANT-1245663. The authors also appreciate the support of Polar Meteorology Group, Byrd Polar and Climate Research Center for providing the AMPS database.

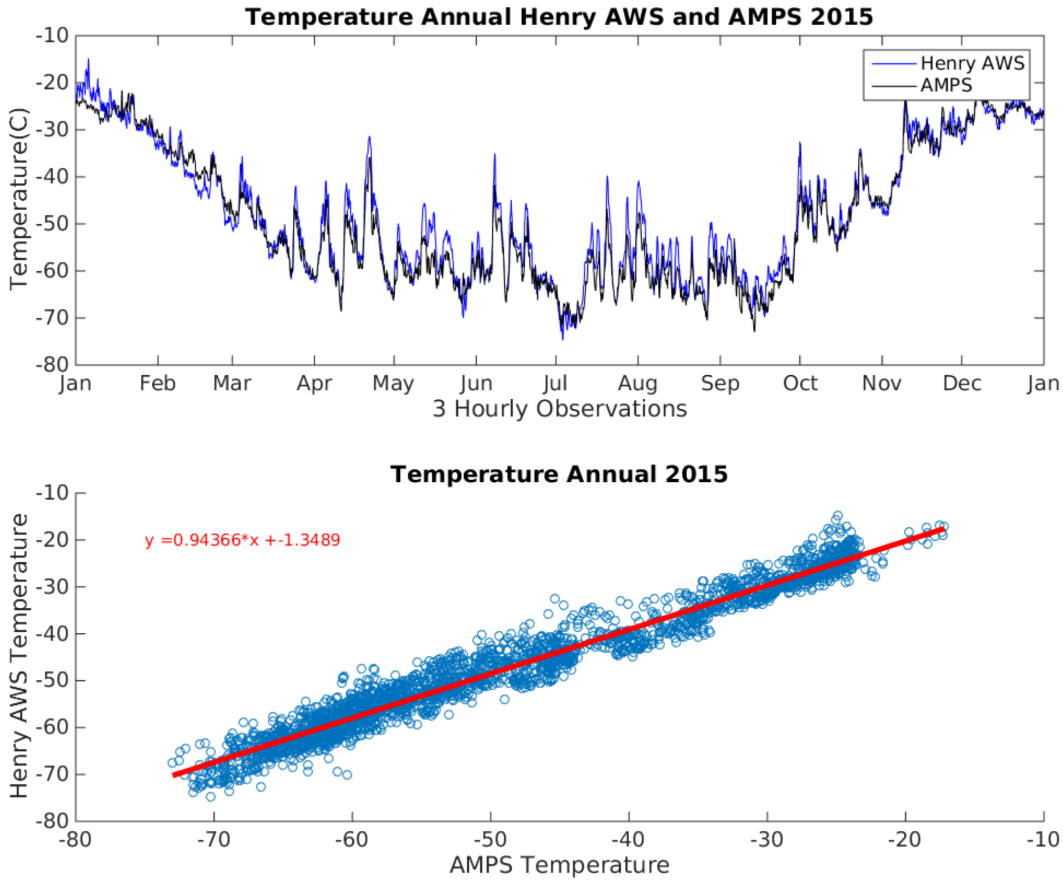

Figure 1: 3-hourly observations and forecasts for 1 year vs. temperature (C) with Henry AWS in blue and AMPS in black for 2015 (top). AMPS 2 m temperature vs. Henry AWS temperature in blue circles circles with the linear regression in red (bottom).

Poster Abstracts

The impact of atmospheric forcing during active convection in the Labrador Sea

Lena Schulze
Florida State University

Hydrographic data from the Labrador Sea collected in February - March 1997, together with atmospheric reanalysis fields, are used to explore relationships between the air-sea fluxes and characteristics of mixed layers. The strongest winds and highest heat fluxes occurred in February, due to the nature and tracks of the storms. While greater numbers of storms occurred earlier and later in the winter, the storms in February followed a more organized track extending from the Gulf Stream region to the Irminger Sea where they slowed and deepened. The canonical low pressure system that drives convection is located east of the southern tip of Greenland, with strong westerly winds advecting cold air off the ice edge over the warm ocean. The deepest mixed layers were observed in the western interior basin, although the variability in mixed layer depth was greater in the eastern interior basin. The overall trend in mixed layer depth through the winter in both regions of the basin was consistent with that predicted by a 1-D mixed layer model. We argue that the deeper mixed layers in the west were due to the enhanced heat fluxes on that side of the basin as opposed to oceanic preconditioning. Investigation of the small scale variability within the mixed layers reveals that temperature and salinity intrusions are more common at the base of the mixed layers, with no apparent geographical pattern. During storms there were more non-density compensating intrusions present compared to the periods between storms, and the small scale variability was enhanced near the base of the mixed layer.

A COMPARISON OF AUTOMATIC WEATHER STATION MEASUREMENTS AT DOME C, ANTARCTICA

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http://amrc.ssec.wisc.edu/

1. OVERVIEW

For the past 36 years, the University of Wisconsin-Madison's Antarctic Meteorological Research Center (AMRC) has operated an Automatic Weather Station (AWS) at Dome C, Antarctica. The current UW AWS, Dome C II AWS, is located high on the expansive Antarctic Plateau making it useful for calibration and validation of the Moderate Resolution Imaging Spectrometers (MODIS) on board NASA's Terra and Aqua satellites. A comprehensive comparison has been performed between Dome C II and four other AWSs at Dome C to assess the observation techniques and data gathered in the area and to ensure that the surface observations are as precise and dependable as possible. The AWSs are compared first in terms of meteorological data collected and second in terms of the methods used to obtain and disseminate those data. Additionally, the future of Dome C II is discussed in light of its age and decreasing reliability during austral winter months.

2. DATA COMPARISON

Dome C II is compared with four other AWSs at Dome C—one Italian and three French AWSs—in terms of temperature, pressure, wind speed, and wind direction for the year 2014. It was found that Dome C II consistently records warmer temperatures than the other AWSs during austral summer months but comparable temperatures during the austral winter. It was also found that there is a very strong correlation between Dome C II and the other AWSs in terms of pressure. While there are subtle discrepancies in wind speed measurements throughout the year, the recorded wind directions show little variation.

3. DATA ACQUISITION/DISSEMINATION METHODOLOGY

Apart from the meteorological variables, the five AWSs are also related with reference to data acquisition and availability practices. The three Antarctic programs with an AWS at Dome C, which include the AMRC, the French Institut Polaire Français Paul-Émile Victor (IPEV), and the Italian Programma Nazionale di Ricerche in Antartide (PNRA), all use different standards when it comes to automated observing. Each program takes measurements at contrasting time intervals, stores data individually, and has different requirements for scientists looking to obtain data. This study has brought to light the discrepancies in observing methodologies at Dome C and points out the problems and inefficiencies with these disparities.

4. ACKNOWLEDGEMENTS

This material is based upon the work supported by the National Science Foundation grant number ANT-1245663. Additionally, the authors would like to thank Carol Costanza and Lee Welhouse (AMRC) as well as Christophe Genthon (IPEV), Paolo Grigioni (PNRA), and Christopher Shuman (NASA Goddard / UMD-Baltimore County).

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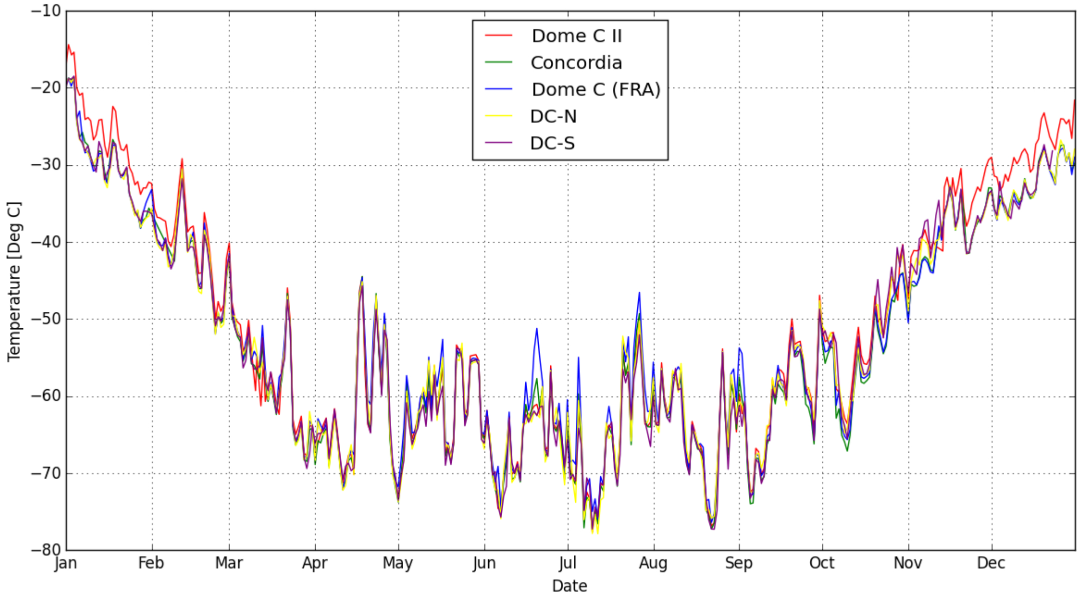

Daily average temperatures from the five AWSs located at Dome C for the year 2014

Display of AMPS Tabular Forecasts for Williams Field, Antarctica

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Abstract:

AMPS table forecasts are often used as initial input for weather outlooks and Terminal Aerodrome Forecasts in the United States Antarctic meteorology program. Forecasted weather elements of wind speed and direction, including gusts*, snowfall, horizontal visibility*, ceiling heights below 3,000 feet*, altimeter setting, temperature, dew point temperature, and wind chill** are displayed in a table for either 39 hours (1km and 3km grid resolutions) at hourly intervals or for 120 hours (10km grid resolution) at 3-hourly intervals. A blended forecast from 1km, 3km, and 10km grid windows at both 00Z and 12Z initial times is also compared to the 10km forecasts. MS Excel formulae and conditional formatting were used to automatically display the AMPS forecasts. Forecasters need only copy the AMPS table forecasts into one sheet in the Excel workbook and the forecasts appear on another sheet. The tabular display quickly allows forecasters to assess weather elements and spot significant weather events that have a potential to impact operations around McMurdo, Antarctica. Future work will include expanding the period of record, verifying more weather elements, and testing various spatial and temporal scales at different locations.

*Inferred values based on forecaster Rules of Thumb or published studies. **Calculated from forecasted temperature and wind speed.

USAP Williams Field (NZWD) (lat, lon) = (-77.870, 167.028)
AMPS Consolidated Forecast 04/04/2016

TIME			WIND				WEATHER		CLOUDS				TEMP		
Day	Hour Z	Hour	Dir		Sp	Gust	Snow	VISIBILITY	SFC	010'	030'	ALTSG	T(C)	Td	
04	00	13L	SE	⇖	6 KT			7 NSW				29.47	-35	-43	Monday
04	03	16L	ESE	⇖	8 KT			7 NSW				29.49	-37	-43	
04	06	19L	E	⇦	8 KT			7 NSW				29.52	-39	-42	
04	09	22L	ENE	⇦	10 KT			7 NSW				29.51	-40	-44	
04	12	01L	E	⇦	8 KT			7 NSW				29.48	-40	-44	
04	15	04L	NE	⇙	6 KT			7 NSW				29.46	-39	-43	
04	18	07L	ENE	⇦	4 KT			7 NSW				29.42	-37	-42	
04	21	10L	SSW	⇧	4 KT			7 NSW				29.38	-35	-41	
05	00	13L	SW	⇗	4 KT			7 NSW				29.33	-34	-39	Tuesday
05	03	16L	SW	⇗	4 KT			7 NSW				29.29	-33	-36	
05	06	19L	S	⇧	2 KT			2-3 BR	BKN000			29.24	-32	-34	
05	09	22L	NE	⇙	2 KT			2-3 BR	OVC000			29.19	-32	-33	
05	12	01L	ENE	⇙	4 KT			2-3 BR	SCT000			29.14	-32	-35	
05	15	04L	ENE	⇦	6 KT			3-4 BR				29.09	-32	-34	
05	18	07L	ESE	⇖	8 KT			3-4 BR	OVC000			29.06	-33	-35	
05	21	10L	SE	⇖	10 KT			4-5 BR	BKN000			29.04	-33	-34	
06	00	13L	ESE	⇦	8 KT			3-4 BR	SCT000			29.02	-33	-34	Wednesday
06	03	16L	SE	⇖	6 KT			3-4 BR	OVC000			29.00	-32	-32	
06	06	19L	S	⇧	6 KT			3-4 BR	OVC000			28.98	-30	-30	
06	09	22L	SSW	⇧	4 KT			2-3 BR	OVC000			28.96	-29	-30	
06	12	01L	WSW	⇗	2 KT			7 NSW	OVC000			28.95	-28	-30	
06	15	04L	ENE	⇙	6 KT			3-4 BR	SCT000			28.93	-29	-31	
06	18	07L	ENE	⇦	10 KT			7 NSW				28.91	-29	-33	
06	21	10L	E	⇦	8 KT			7 NSW				28.89	-31	-34	
07	00	13L	ENE	⇦	8 KT			3-4 BR	FEW000			28.87	-31	-33	Thursday
07	03	16L	E	⇦	8 KT			3-4 BR	OVC000			28.84	-31	-33	
07	06	19L	ESE	⇦	8 KT			3-4 BR	OVC000			28.81	-32	-33	
07	09	22L	ESE	⇖	8 KT			3-4 BR	FEW000		FEW030	28.78	-33	-35	
07	12	01L	ESE	⇖	10 KT			4-5 BR	SCT000			28.77	-34	-36	
07	15	04L	ESE	⇖	10 KT			4-5 BR	BKN000			28.76	-35	-36	
07	18	07L	SE	⇖	12 KT		❄	3-4 SN-/BR	BKN000		FEW030	28.78	-34	-35	
07	21	10L	SE	⇖	8 KT		❄	2-3 SN-/BR	OVC000	FEW010	FEW030	28.81	-33	-33	
08	00	13L	ENE	⇙	6 KT		❄	1-2 SN/BR	OVC000	FEW010	FEW030	28.85	-31	-31	Friday
08	03	16L	E	⇦	8 KT		❄	2-3 SN-/BR	OVC000		FEW030	28.90	-30	-31	
08	06	19L	ENE	⇙	10 KT			4-5 BR	SCT000		FEW030	28.95	-30	-32	
08	09	22L	ENE	⇙	10 KT			4-5 BR	FEW000		FEW030	29.00	-30	-32	
08	12	01L	E	⇦	10 KT			4-5 BR	BKN000		FEW030	29.05	-30	-32	
08	15	04L	ESE	⇦	12 KT			4-5 BR			FEW030	29.11	-30	-32	
08	18	07L	E	⇦	12 KT			4-5 BR	FEW000		FEW030	29.18	-30	-32	
08	21	10L	SE	⇖	12 KT			4-5 BR	FEW000		FEW030	29.22	-30	-32	

************THIS GENERAL 5-DAY FORECAST IS BASED ON AMPS MODEL DATA. OFFICIAL FORECASTS ISSUED BY MACWEATHER SUPERSEDE THIS OUTLOOK. SKY CONDITION IS ONLY FOR CLOUDS BELOW 4,000FT. FEW≡0/8THs TO 2/8THs; SCT=SCATTERED≡3/8THs TO 4/8THs; BKN=BROKEN≡5/8THs TO 7/8THs; AND OVC=OVERCAST≡8/8THs. BKN000 MEANS POSSIBLE OBSCURATION AT THE SURFACE (I.E., FOG OR BLOWING SNOW); BKN030 MEANS A CLOUD CEILING AT 3,000FT. THE ALTIMETER SETTING (ALSTG) OR PRESSURE IS GIVEN IN INCHES OF HG. CONTACT MACWEATHER AT X2524 IF YOU HAVE ANY QUESTIONS ABOUT THE FORECAST.*************

THE IMPLICATIONS OF CLIMATE CHANGE ON ANTARCTIC INTERNATIONAL RELATIONS

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1. OVERVIEW

As Antarctica is one of the least polluted environments on Earth, it is important to know how this environment is impacted by current climate change. With ice melting as an ongoing problem, it is crucial to be aware of the global impact it will have on the world community and on some regional activities, such as tourism and whaling. This project explores the climate of Antarctica and the impact of other countries' local activities for the future. Results from recent investigations are used to outline the current climate, and illustrations of future climate are assessed from the Monash University simple climate model.

In the future, some countries may be looking forward to benefitting from raw resources available in Antarctica. Tourism and whaling are the two example activities that some nations are already engaged in. Other countries are worried about destroying the pure Antarctic environment by exploiting natural resources. The Antarctic Treaty limits activities only to three peaceful purposes:

- Freedom of scientific investigation
- Cooperation among countries
- Exchange of scientific observation results among nations

Further regulations have been added to protect the Antarctic environment via the Madrid Protocol. In addition, the International Whaling Commission has been imposing regulations to stop countries that are excessively hunting whales.

Melting sea ice and warming temperatures are allowing countries and organizations increased access to Antarctica. There are many countries that are coming to establish their scientific research and expand new stations and routes.

2. ACKNOWLEDGEMENTS

The authors wish to thank the support of the Madison College Honors Program and Dr. Julia Hasleau. The authors also wish to thank Monash University for the availability of its simple climate modeling system. This material is based upon the work supported by the National Science Foundation grant number ANT-1245663.

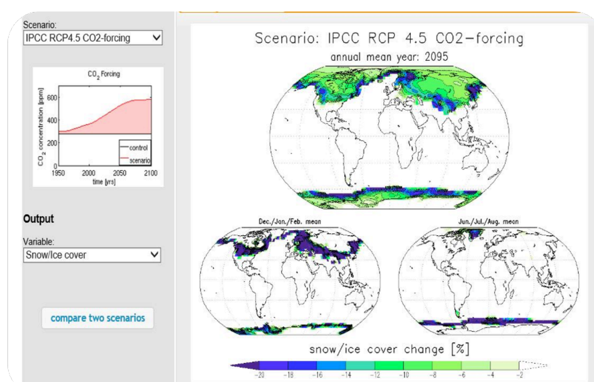

Figure 1. A sample output display of snow and ice cover change from the Monash University simple climate model driven with the IPCC RCP4.5 CO2 forcing.

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